CONICAL SCANNING MICROWAVE IMAGER/SOUNDER (CMIS)

Sensor Requirements Document (SRD)

for

NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS) SPACECRAFT AND SENSORS

Prepared by

Associate Directorate for Acquisition
NPOESS Integrated Program Office

This document is in two sections—this section contains unique information. Information shared by all sensors is in the Common section.

Revision 2
10 December 1998

Integrated Program Office
Silver Spring MD 20910

TABLE OF CONTENTS FOR UNIQUE SECTION

Tables of Contents for the Common Section are in the Common Sections

LIST OF FIGURES FOR UNIQUE SECTION

LIST OF TABLES FOR UNIQUE SECTION

APPENDICES

1 SCOPE

1.1 IDENTIFICATION

This Sensor Requirements Document sets forth the requirements of the CONICAL SCANNING MICROWAVE IMAGER/SOUNDER which is part of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and is hereinafter referred to as the CMIS.

1.2 SENSOR OVERVIEW

The purpose of the CMIS is to collect global microwave radiometry and sounding data. These data will be processed to produce microwave imagery and other specialized meteorological and oceanographic data using algorithms developed in conjunction with the flight hardware. These data will be processed from Raw Data Records (RDRs) into Sensor Data Records (SDRs), Temperature Data Records (TDRs) and Environmental Data Records (EDRs). Data will be disseminated to users worldwide by the Department of Defense, Department of Commerce and the European Meteorological Organization.

1.3 DOCUMENT OVERVIEW

This document contains all performance requirements for the CMIS sensor suite. The contractor should use this document as the basis of a proposed sensor suite specification. The documentation listed in Section 2.0 follows an approach of minimum specifications and standards. The contractor may add to or revise the documents listed in Section 2.0 in coordination with the government. Section 3, Sensor Requirements, provides the detailed requirements for the CMIS sensor suite. This section includes the CMIS performance characteristics, design and construction, and related specifications.

The term "(**TBD**)" applied to a missing requirement means that the contractor should determine the missing requirement in coordination with the government. The term "(**TBS**)" means that the government will supply the missing information in the course of the contract. The term "(**TBR**)" means that the requirement is subject to review for appropriateness by the contractor or the government. The government may change "(**TBR**)" requirements in the course of the contract.

Section 4, Quality Assurance and Testing Provisions, provides for the testing, verification and quality assurance for the CMIS sensor suite. Of particular note in this section is the Verification Cross Reference (Section 4.3) and the related matrix (Appendix H). Section 5, Preparation and Delivery, covers preservation, packaging, and marking for the CMIS sensor suite. Appendix A contains a definition of the terms used throughout the document. Appendix B, NPOESS Survivability Requirements, is classified and will be made available after contract award. Appendix C provides characteristics of the SDRs, and is presently (TBR). Appendix D of the TRD contains the NPOESS EDR requirements. Appendix E contains the RDRs and EDRs required for each Central and Field Terminal (TBR). Appendix F defines the acronyms and abbreviations used throughout the document. Appendix G describes Potential Pre-planned Product Improvements. Appendix H is the Verification Cross Reference Matrix (**TBD**).

1.3.1 CONFLICTS

SRDC1.3.1-1
In the event of conflict between any referenced documents and the contents of this specification, the contents of this specification shall be the superseding requirements.

SRDC1.3.1-2
In the event of a conflict involving the external interface requirements, or in the event of any other unresolved conflict, the contracting officer shall determine the order of precedence.

1.3.2 REQUIREMENT WEIGHTING FACTORS

The requirements stated in this specification are not of equal importance or weight. The following three paragraphs define the weighting factors incorporated in this specification.

a. ***Shall*** designates the most important weighting level; that is, mandatory. Any deviations from these contractually imposed mandatory requirements require the approval of the contracting officer.
b. **S*hould*** designates requirements requested by the government and are not mandatory. Unless required by other contract provisions, noncompliance with the *should* requirements does not require approval of the contracting officer.
c. ***Will*** designates the lowest weighting level. These *will* requirements designate the intent of the government and are often stated as examples of acceptable designs, items and practices. Unless required by other contract provisions, noncompliance with the *will* requirements does not require approval of the contracting officer and does not require documented technical substantiation.

1.4 SYSTEM CLASSIFICATIONS N/A

2 APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this SRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is (TBR).

SPECIFICATIONS:

Military

DOD-E-83578A May 96	General Specification for Explosive Ordnance for Space Vehicles
Mil-A-83577B Feb 88	Moving Mechanical Assemblies for Space Launch Vehicles
MIL-C-24308 Apr 97	General Specification for Connectors, Electric, Rectangular, Non-Environmental, Miniature, Polarized Shell, Rack, and Panel
MIL-C-38999 Dec 97	Connectors, Receptacle, Electrical, Circular, Breakaway Wall Mounting Flange, Removable Crimp Contacts, Sockets, Series III, Shell Size 25, Metric

STANDARDS:

Federal

FED-STD-209E Sep 92	Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones

Military

MIL-STD-461D Jan 93	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462D Jan 93	Measurement of Electromagnetic Interference Characteristics
MIL-STD-975 Aug 94	NASA Standard Electrical, Electronic, and Electro-mechanical (EEE) Parts List, Revision M, 5 May 1998
MIL-STD-1540C Sep 94	Test Requirements for Launch, Upper Stage, and Space Vehicles
MIL-STD-1541A	Electromagnetic Compatibility Requirements for Space

Dec 87	Systems
MIL-STD-1553B Jan 96	Digital Time Division Command/Response Multiplex Data Bus

Department of Commerce/NOAA None (TBR)

OTHER PUBLICATIONS:

Regulations

AFM 91-201 7 Oct 94	Explosive Safety Standards
EWR 127-1 31 Mar 95	Eastern and Western Range Safety Requirements

Handbooks None (TBR)

Bulletins None (TBR)

Other

GPS ICD 200 REV C 19 January 1995	"NAVSTAR GPS Space Segment/Navigation User Interface"(U)
GPS ICD 203, REV B 22 Dec 1993	"NAVSTAR GPS SA/AS Requirements"(U) SECRET

(Contractors requiring copies of specifications, standards, handbooks, drawings, and publications in connection with specified acquisition functions should obtain them from the contracting activity or as directed by the contracting officer.)

2.2 NONGOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this SRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1.

SPECIFICATIONS: None (TBR)

STANDARDS:

CCSDS 203.0-B-1 Jan 87	CCSDS Recommendations for Space Data System Standards. Telecommand, Part 3: Data Management Service, Architectural Definition, Issue 1
CCSDS 701.0-B-2 Dec 87	CCSDS Recommendations for Advanced Orbiting Systems, Networks and Data Links, Architectural Specification

ISO/TC 209 (ISO/DIS 14644-1) Jan 97	Cleanrooms and Associated Controlled Environments
National Aerospace Standard (NAS) 411 Rev 2, 29 Apr 94	Hazardous Materials Management Program
SAE AS1773 May 88	Fiber Optics Mechanization of an Aircraft Internal Time Division Command/Response Multiplex Data Bus

DRAWINGS: None (TBR)

OTHER PUBLICATIONS: None (TBR)

2.3 REFERENCE DOCUMENTS

The following documents are for reference only and do not form a part of this specification. They are listed here because various parts of the SRD refer to them.

SPECIFICATIONS:

Military None (TBR)

STANDARDS:

ANSI/ISO 9899 1990	Programming Language--C
DOD 5200.28-STD Mar 88	Department of Defense Trusted Computer System Evaluation Criteria
EIA/IEEE J-STD 016 30 Sep 95	Standard for Information Technology, Software Life Cycle Processes, Software Development, Acquirer-Supplier Agreement
MIL-STD-129M 1 Jun 93	Marking for Shipment and Storage Notice 1, 15 Sep 89
MIL-STD-882c Jan 93	System Safety Program Requirements
MIL-STD 961D Aug 95	DoD Standard Practice for Defense Specifications, w/ Notice 1

MIL-STD-1246C Apr 94	Military Standard Product Cleanliness Levels and Contamination Control Program
MIL-STD-1522A May 84	Standard General requirements for Safe Design and Operation of Pressurized Missile and Space Systems Notice 2: 20 Nov 86; Notice 3: 4 Sep 92
MIL-STD-1542B Nov 91	Electromagnetic Compatibility (EMC) and Grounding Requirements for Space Systems Facilities
MIL-STD-1543B Oct 88	Reliability Program Requirements for Space and Launch Vehicles
MIL-STD-1547A Dec 92	Parts and Materials Program for Space and Launch Vehicles
MIL-STD-1809 Feb 91	(USAF) Space Environments for USAF Space Vehicles
MIL-STD-1815A	ADA Programming Language
TM-86-01	Technical Manual Contract Requirements

Department of Commerce

DOC Sep 95 Edition Sep 95	National Telecommunications and Information Administration, Manual of Regulations for Federal Radio Frequency Management

NOAA

S24.801 Nov 72	Preparation of Operations and Maintenance Manuals, revised Apr 97
S24.806 Jan 86	Software Development, Maintenance, and User Documentation, revised Apr 94
S24.809 Dec 89	Grounding Standards

NASA

PPL-21 March 1995	Preferred Parts List, Goddard Space Flight Center (Updated May 1996)

SP-R-0 022A (JSC) 9 Sep 74	General Specification, Vacuum Stability Requirements of Polymeric Material for Spacecraft Application
NASA Tech Memo 100471	Orbital Debris Environments for Spacecraft Designed to Operate in Low Earth Orbit
SP 8031 1969	NASA Space Vehicle Design Criteria/Structures

OTHER PUBLICATIONS:

Regulations None (TBR)

Handbooks

DOD-HDBK-263B (date)	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, Equipment
MIL-HDBK-340 1 Jul 85	Application Guidelines for MIL-STD-1540B
DOD-W-83575 Jun 96	Gen Spec for Wiring Harness, Space Vehicle, Design and Testing
MIL-I-46058	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)
1985	Handbook of Geophysics and Space Environments
AFM 15-111 1 Sep 96	Surface Weather Observations

Bulletins None

Other

TRD for NPOESS (current version)	Technical Requirements Document (TRD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft Payloads
IRD for NPOESS (current version)	Interface Requirements Document (IRD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft

IORD for NPOESS 28 Mar 96	Integrated Operational Requirements Document (IORD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft Payloads
ASTME-595-93 (current version)	Standard Test method for Total Mass Loss and Collected Volatile Condensable Materials for Outgassing in a Vacuum Environment
Attachment C S-480-80 Revised December 1994	AMSU-A Instrument Performance and Operation Specification (for the EOS/METSAT Integrated Programs); NASA GSFC
SYS/AMS/J0105/ BAE 03 Feb 1993	AMSU-B Instrument System Specification (British Aerospace)

(Technical society and technical association specifications and standards are generally available from reference libraries. They are also available in technical groups and using federal agencies. Contact the contracting officer regarding any referenced document not readily available from other sources.)

3 SENSOR REQUIREMENTS

3.1 DEFINITION

3.1.1 SENSOR DESCRIPTION

The Conical Scanning Microwave Imager/Sounder (CMIS) will be part of the NPOESS System. It will consist of all ground and spaceborne hardware and software necessary to perform calibrated, microwave radiometric measurements from space and the software and science algorithms necessary to process, on the ground, these measurements into a format consistent with the requirements of the assigned Environmental Data Records (EDRs).
Identified below are the Primary and Secondary EDRs assigned to CMIS.

PRIMARY EDRs

Atmospheric Vertical Moisture Profile
Atmospheric Vertical Temperature Profile
Imagery
Sea Surface Winds (Speed and Direction)
Soil Moisture - Surface (Cloudy)
Sea Surface Temperature
Precipitable Water
Precipitation (Type/Rate)
Pressure Profile (Surface/Profile)
Total Water Content
Cloud Base Height
Cloud Ice Water Path
Cloud Liquid Water
Snow Cover/Depth (Cloudy)
Fresh Water Ice Edge Motion (Cloudy)
Ice Surface Temperature (Cloudy)
Sea Ice Age and Sea Ice Edge Motion (Cloudy)
Surface Wind Stress
Land Surface Temperature
Vegetation/Surface Type

SECONDARY EDRs

(**TBS**)

The requirements for each of the above EDRs are discussed in Paragraph 3.2.1.1.1.1. Please note that, for some of the EDRs listed in Paragraph 3.2.1.1.1.1, the Threshold and/or Objective values are different from the values specified in Appendix D of the TRD; where changes have been made, the requirements of Paragraph 3.2.1.1.1.1 take precedence.

3.1.2 SYSTEM SEGMENTS N/A

3.1.3 SPECIFICATION TREE

The partial specification tree for the System is shown in Figure 3.1.3.

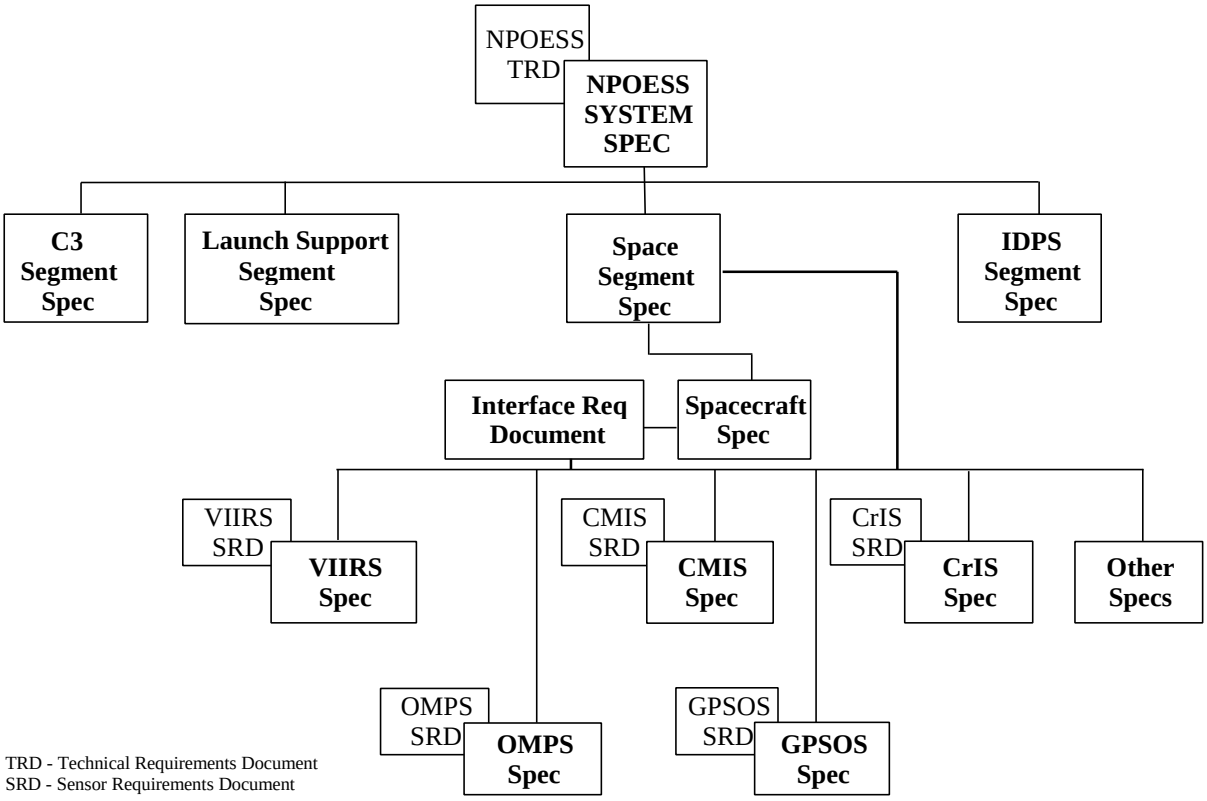

Figure 3.1.3 Partial Specification Tree

3.1.4 TOP-LEVEL FUNCTIONS

3.1.4.1 Top-Level Sensor Functions

The top-level functions which the CMIS instrument will perform include the following:

- Measurement of scene brightness temperatures,
- On-orbit calibration,
- Preparation and transmission of RDR data to the spacecraft,
- Reporting instrument health and status,
- Reception and appropriate response to command and control data.

3.1.4.2 Top-Level Algorithm Functions

SRDC3.1.4.2-1
Science algorithms shall process CMIS data, and other data as required, to provide the Environmental Data Records assigned to CMIS.

3.1.5 SENSOR MODES

3.1.5.1 Sensor Off Mode

SRDC3.1.5.1-1
In the Sensor Off mode, no power shall be supplied to the sensor.

3.1.5.2 Sensor Operational Mode

SRDC3.1.5.2-1
The sensor shall be in full functional configuration during this mode.

SRDC3.1.5.2-2
Mission and housekeeping data shall be collected and transmitted.

SRDC3.1.5.2-3
Calibrations shall be done during regular operations.

3.1.5.3 Sensor Diagnostic Mode

SRDC3.1.5.3-1
The Sensor Diagnostic Mode shall include troubleshooting and software updates.

3.1.5.4 Sensor Safe Hold Mode

In the Safe Hold Mode, health and status data are collected and transmitted. Mission and calibration data are not collected. The Safe Hold Mode is a power conservation mode.

SRDC3.1.5.4-1
The Sensor shall accept a command in the event the spacecraft enters an anomalous configuration or orientation as determined by the spacecraft computer. A power subsystem anomaly is such an event.
The C&DH will issue power conservation re-configuration commands to the sensors, via the data bus, that will place the sensor in a safe configuration. The return to the Sensor Operations Mode requires ground intervention.

SRDC3.1.5.4-2
In this mode most subsystems shall be turned off, with survival heaters activated.

3.1.5.5 CMIS Specific Sensor Modes (TBR)

SRDC3.1.5.5-1
The CMIS contractor shall recommend to the Government additional CMIS-specific modes. The recommended modes may include System Test Mode, Storage Mode,

Transport Mode, Pre-launch Mode, Launch and Ascent Mode, Deployment and Initialization Mode, and Calibration and Validation Mode.

3.1.6 OPERATIONAL AND ORGANIZATIONAL CONCEPT

3.1.6.1 Expendable Launch Vehicle Concept N/A

3.1.6.2 Launch Operations Concept

3.1.6.2.1 Pre-launch

The CMIS sensors will be delivered and integrated onto the specified satellite platforms. During integration various CMIS verification tests will be required.

3.1.6.2.2 Launch

During launch and injection to the operational orbit, the CMIS subsystems will be powered off, unless recommended otherwise by the vendor, in order to provide protection from the launch and injection environments. Spacecraft telemetry to monitor vehicle status will be provided during launch and injection; transmission of launch vehicle telemetry may be used to satisfy this requirement during the launch phase. Spacecraft telemetry transmission to ground monitoring stations will be used to the extent practicable during the injection phase. After insertion into its operational orbit and separation from the launch vehicle, appropriate deployments will be initiated by memory command. Early orbit check-out will be conducted at the NPOESS primary SOC in Suitland, MD.

SRDC3.1.6.2.2-1
The contractor shall identify all CMIS specific requirements for power, telemetry, etc. during launch and ascent.

3.1.6.3 On-orbit Operational Concept

The NPOESS spacecraft will operate in a near circular, sun-synchronous orbit. The nominal orbit for the spacecraft is 833 km altitude, 98.7 degree inclination. The orbit will be a "precise" orbit (i.e., altitude maintained to □ 17 (TBR) km, ±0.05 (TBR) degrees inclination, nodal crossing times maintained to □ 10 minutes throughout the mission lifetime) to minimize orbital drift (precession). NPOESS must be capable of flying at any equatorial node crossing time. However, the nominal configuration is with the satellite orbits equally spaced, with 0530 and 1330 nodal crossing times for the U.S. Government spacecraft and 2130 for the EUMETSAT Meteorological Observation Satellite (METOP) spacecraft.

The sun Beta angle, ↕, is the angle between the solar vector (i.e., the spacecraft-sun line) and the orbit plane. For instrument thermal design purposes, the range of ↕ for the NPOESS missions is ± 90 degrees. The satellite will maintain the sun on the appropriate side of the satellite to meet the "all beta" requirement.

SRDC3.1.6.3-1
The sensor suite design shall allow for approximately a 5 degree infringement of sun on the cold space side of the spacecraft in the case of a noon or midnight orbit.

3.1.6.3.1 On-orbit Tests

The initial on-orbit period will be devoted to a complete spacecraft checkout and the calibration and performance verifications of the payloads, including the CMIS. The spacecraft and payload performance verification tests may be repeated at appropriate times during the operational phase of the mission.

3.1.6.3.2 On-orbit Operations (TBR)

SRDC3.1.6.3.2-1
On-orbit, the CMIS shall continuously perform all required measurements. Real-time data are continuously sent to the spacecraft for broadcast so that users within the field of view of the spacecraft data transmitters may receive the data.

SRDC3.1.6.3.2-2
The CMIS shall receive commands from the satellite as required to support the NPOESS mission.

SRDC3.1.6.3.2-3
The CMIS sensor shall be capable of operating for 21 days (with an objective of 60 days) without additional commands, i.e., autonomous operation.

3.1.7 MISSIONS

The mission of CMIS is to provide an enduring capability for providing measurements on a global basis of various atmospheric, land, and sea parameters of the Earth using microwave remote sensing techniques. The CMIS instrument will collect relevant information from a spaceborne platform, and utilize scientific algorithms to process that information on the ground into designated Environmental Data Records; CMIS consists of all spaceborne hardware, any ground-based test and support equipment, and the associated ground-based science algorithms. The Environmental Data Records will be disseminated to military, civil, and international users of the data throughout the world. The specific measurement requirements which CMIS must perform are identified in the assigned Primary EDRs and Secondary EDRs. These requirements have been prepared in coordination with, and approved by, the Departments of Defense and Commerce.

3.2 SENSOR SUITE CHARACTERISTICS

3.2.1 PERFORMANCE CHARACTERISTICS

SRDC3.2.1-1
The performance characteristics of the CMIS shall be developed by the vendor based upon the data product requirements of the EDRs assigned to the CMIS and any other requirements specified herein.

SRDC3.2.1-2
Sensor level requirements shall be derived by the contractor based on a flowdown of EDR requirements to instrument performance requirements using the contractor's EDR science algorithms and any specification provided in the CMIS SRD.

SRDC3.2.1-3
If a derived requirement conflicts with an explicit requirement and/or another requirement, the most stringent requirement shall be satisfied.

SRDC3.2.1-4
Unless otherwise specified, all performance requirements within Section 3.2.1 shall be met over the design service life of the CMIS and under all operational environmental conditions.

3.2.1.1 Performance Requirements

3.2.1.1.1 EDR Requirements

SRDC3.2.1.1.1-1
The environmental data records listed in Section 3.2.1.1.1.1 are the measurement requirements which shall be satisfied by CMIS. Please note that the EDR requirements specified in Paragraph 3.2.1.1.1.1 may have different Thresholds and/or Objectives than the values contained in Appendix D of the NPOESS TRD.
Note: Supplemental information concerning conventions/general EDR requirements can be found in Section 40.1 of Appendix D and are to be followed unless found to be in conflict with modifications and clarifications of EDR requirements identified in this section.

SRDC3.2.1.1.1-2
In the event of conflict, the values specified in Paragraph 3.2.1.1.1.1 shall take precedence.

SRDC3.2.1.1.1-3
As a minimum, the EDR requirements shall be satisfied at the threshold level.

SRDC3.2.1.1.1-4
In the event the requirements for an EDR cannot be fully satisfied, the contractor shall identify the requirements which are not fully satisfied, and specify the conditions when they will not be satisfied.

SRDC3.2.1.1.1-5
The contractor shall also specify the conditions under which it recommends delivering an EDR which is incomplete and/or of degraded quality, but which is still of potential utility to one or more users.

SRDC3.2.1.1.1-6
The CMIS contractor shall identify specifications for any data required from other sources in order to meet the attribute requirements of the primary EDRs assigned to the CMIS sensor.

3.2.1.1.1.1 EDR Requirements

Identified below are the EDRs which CMIS must satisfy. The EDRs have been grouped into Primary and Secondary EDRs. The attribute numbering is consistent with Appendix D of the TRD except for the preface letter ("C") which indicates it is a unique requirement in this SRD. Any difference in these attributes take precedence over Appendix D values as they reflect an intentional requirements allocation to this sensor.

SRDC3.2.1.1.1.1-1
For the EDRs appended with "(cloudy)" listed in paragraph 3.1.1, above, CMIS shall satisfy the EDR Thresholds associated with cloudy conditions under all measurement conditions, i.e., in clear conditions, cloudy conditions, or any amount of cloud cover.

SRDC3.2.1.1.1.1-2
The requirements for data to be provided by other sensors to CMIS (e.g., other sensor Secondary EDRs) shall be defined by the CMIS contractor no later than 60 days prior to each of the other sensors' Systems Requirements Review (SRR).

SRDC3.2.1.1.1.1-3
Requirements for the following Primary EDRs shall be satisfied using sensing data acquired by the CMIS and science algorithms developed by the CMIS contractor. The science algorithm may or may not require the use of additional data from other than CMIS.

SRDC3.2.1.1.1.1-4
The contractor shall advise the government of data requirements from sources external to CMIS.

Atmospheric Vertical Moisture Profile **TRD App D Section 40.2.1**

An atmospheric vertical moisture profile is a set of estimates of the average mixing ratio in three-dimensional cells centered on specified points along a local vertical. The mixing ratio of a sample of air is the ratio of the mass of water vapor in the sample to the mass of dry air in the sample.

Para. No.		Thresholds	Objectives
C40.2.1-1	a. Horizontal Cell Size	15 km	2 km
C40.2.1-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.2.1-3	c. Vertical Cell Size	2 km	2 km
	d. Vertical Reporting Interval		
C40.2.1-4	1. Surface to 850 mb	20 mb	5 mb
C40.2.1-5	2. 850 mb to 100 mb	50 mb	15 mb
C40.2.1-6	e. Horizontal Coverage	Global	Global
C40.2.1-7	f. Vertical Coverage	Surface to 100 mb	Surface to 100 mb
C40.2.1-8	g. Measurement Range	0 - 30 g/kg	0 - 30 g/kg
	h. Measurement Uncertainty (expressed as a percent of average mixing ratio in 2 km layers)		
	Clear		
C40.2.1-9	1. Surface to 600 mb	20 % or 0.2 g/kg (TBR)	10 %
C40.2.1-10	2. 600 mb to 300 mb	35 % or 0.1 g/kg (TBR)	10 %
C40.2.1-11	3. 300 mb to 100 mb	35 % or 0.1 g/kg (TBR)	10 %
	Cloudy		
C40.2.1-12	4. Surface to 600 mb	20 % or 0.2 g/kg (TBR)	10 %
C40.2.1-13	5. 600 mb to 300 mb	40 % or 0.1 g/kg (TBR)	10 %
C40.2.1-14	6. 300 mb to 100 mb	40 % or 0.1 g/kg (TBR)	10 %
C40.2.1-15	i. Mapping Uncertainty	5 km	1 km
C40.2.1-16	j. Swath Width	1700 km (TBR)	3000 km (TBR)

Atmospheric Vertical Temperature Profile **TRD App D Section 40.2.2**

An atmospheric temperature profile is a set of estimates of the average atmospheric temperature in three-dimensional cells centered on specified points along a local vertical.

Para. No.		Thresholds	Objectives
C40.2.2-1	a. Horizontal Cell Size	40 km	5 km
C40.2.2-2	Deleted		
C40.2.2-3	Deleted		
C40.2.2-4	Deleted		
C40.2.2-5	b. Horizontal Reporting Interval	(TBD)	(TBD)
	c. Vertical Cell Size		
	Clear		
C40.2.2-6	1. Surface to 300 mb	1 km	(TBD)
C40.2.2-7	2. 300 mb to 30 mb	3 km	(TBD)
C40.2.2-8	3. 30 mb to 1 mb	5 km	(TBD)
C40.2.2-9	4. 1 mb to 0.01 mb	5 km	(TBD)
	Cloudy		
C40.2.2-10	5. Surface to 700 mb	1 km	(TBD)
C40.2.2-11	6. 700 mb to 300mb	1 km	(TBD)
C40.2.2-12	7. 300 mb to 30 mb	3 km	(TBD)
C40.2.2-13	8. 30 mb to 1 mb	5 km	(TBD)
C40.2.2-14	9. 1 mb to 0.01 mb	5 km	(TBD)
	d. Vertical Reporting Interval		
C40.2.2-15	1. Surface to 850 mb	20 mb	15 mb
C40.2.2-16	2. 850 mb to 300 mb	50 mb	15 mb
C40.2.2-17	3. 300 mb to 100 mb	25 mb	15 mb
C40.2.2-18	4. 100 mb to 10 mb	20 mb	10 mb
C40.2.2-19	5. 10 mb to 1 mb	2 mb	1 mb
C40.2.2-20	6. 1 mb to 0.1 mb	0.2 mb	0.1 mb
C40.2.2-21	7. 0.1 mb to 0.01 mb	0.02 mb	0.01 mb
C40.2.2-22	e. Horizontal Coverage	Global	Global
C40.2.2-23	f. Vertical Coverage	Surface to 0.01 mb	Surface to 0.01 mb
C40.2.2-24	g. Measurement Range	180-335K	162-335K (TBR)
C40.2.2-25	Not used		
	h. Measurement Uncertainty		
	Clear		
C40.2.2-26	1. Surface to 300 mb	1.6 K / 1 km layers	0.5K / 1km
C40.2.2-27	2. 300 mb to 30 mb	1.5 K / 3 km layers	0.5K / 1km
C40.2.2-28	3. 30 mb to 1 mb	1.5 K / 5 km layers	0.5K / 1km
C40.2.2-29	4. 1 mb to 0.01 mb	3.5 K / 5 km layers	0.5K / 1km
	Cloudy		
C40.2.2-30	5. Surface to 700 mb	2.5 K / 1 km layers (TBR)	0.5K / 1km
C40.2.2-31	6. 700 mb to 300 mb	1.5 K / 1 km layers (TBR)	0.5K / 1km
C40.2.2-32	7. 300 mb to 30 mb	1.5 K / 3 km layers (TBR)	0.5K / 1km
C40.2.2-33	8. 30 mb to 1 mb	1.5 K / 5 km layer (TBR)	0.5K / 1km
C40.2.2-34	9. 1 mb to 0.01 mb	3.5 K / 5 km layers (TBR)	0.5K / 1km
C40.2.2-35	i. Mapping Uncertainty	5 km	1 km
C40.2.2-36	j. Swath Width	1700 km (TBR)	3000 km (TBR)

Imagery **TRD App D Section 40.2.3**

SRDC3.2.1.1.1.1-5
Brightness temperature data from each microwave channel shall be available for display at the sampled resolution. The threshold horizontal spatial resolution (HSR) is to be consistent with the performance of the related EDRs. The display capability for all imagery should be consistent with the dynamic range of any CMIS channel.

Para. No.		Thresholds	Objectives
	a. Horizontal Spatial Resolution		
C40.2.3.1-1	1. Global	Consistent with related EDRs	(TBD)
C40.2.3.1-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
	c. Horizontal Coverage		
C40.2.3.1-3	1. Global	Global	Global
C40.2.3.1-4	2. Regional	Up to 1/2 orbit, non-contiguous, commandable by SOC	Up to 1/2 orbit, non-contiguous, commandable by SOC
C40.2.3.1-5	d. Measurement Range	Dynamic range of all measurement channels	Dynamic range of all measurement channels
C40.2.3.1-6	e. Measurement Uncertainty (TBR)	Derived	Derived
C40.2.3.1-7	f. Mapping Uncertainty	3 km (TBR)	(TBD)

Sea Surface Temperature (SST) **TRD App D Section 40.2.4**

Sea surface temperature (SST) is defined as the skin temperature of the ocean surface water. The measured radiances should enable the derivation of both skin and surface layer (1 meter depth) sea surface temperature to the specifications listed below, though an EDR algorithm is only required for skin temperature.

Para. No.		Thresholds	Objectives
C40.2.4-1	a. Horizontal Cell Size	50 km	25 km (TBR)
C40.2.4-2	Deleted		
C40.2.4-3	Deleted		
C40.2.4-4	Deleted		
C40.2.4-5	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.2.4-6	c. Horizontal Coverage	Oceans	Oceans
C40.2.4-7	Deleted		
C40.2.4-8	d. Measurement Range	271 K - 313 K	271 K - 313 K
C40.2.4-9	e. Measurement Uncertainty (TBR)	0.5 K (TBR)	0.1 K
C40.2.4-10	f. Measurement Accuracy	(TBD)	0.1 K
C40.2.4-11	g. Measurement Precision	(TBD)	0.1K
C40.2.4-12	h. Mapping Uncertainty	5 km	1 km (TBR)
C40.2.4-13	Deleted		
C40.2.4-14	Deleted		
C40.2.4-15	Deleted		
C40.2.4-16	i. Swath Width	1700 km (TBR)	3000 km (TBR)

Sea Surface Winds (Speed and Direction) **TRD App D Section 40.2.5**

Atmospheric wind speed and direction at the sea/atmosphere interface. This parameter is to be reported at 19.5 meters above sea level.

Para. No.		Thresholds	Objectives
C40.2.5-1	a. Horizontal Cell Size	20 km	1 km
C40.2.5-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.2.5-3	c. Horizontal Coverage	Oceans	Oceans
	d. Measurement Range		
C40.2.5-4	1. Speed	3 - 25 m/s	1 - 50 m/s
C40.2.5-5	2. Direction	0 - 360 deg	0 - 360 deg
	e. Measurement Accuracy		
C40.2.5-6	1. Speed	2 m/s or 20 % of true value, whichever is greater	1 m/s or 10 % of true value, whichever is greater
C40.2.5-7	2. Direction	20 deg for wind speeds greater than 5 m/s. 20deg(TBR) for wind speeds from 3 - 5 m/s	10 deg
	f. Measurement Precision		
C40.2.5-8	1. Speed	1 m/s	1 m/s
C40.2.5-9	2. Direction	10 deg	10 deg
C40.2.5-10	g. Mapping Uncertainty	5 km	1 km
C40.2.5-11	h. Swath Width	1700 km	3000 km (TBR)

Soil Moisture **TRD App D Section 40.2.6**

Total water in all phases in the soil or in a surface layer over soil. The threshold requirement is to measure soil moisture only within a thin layer at the surface (0.1 cm thick) and only for bare soil in regions with known soil types. The objective is to measure a moisture profile for any soil, whether bare or not, and whether or not the soil type is known.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
C40.2.6-1	1. Clear	40 km	(TBD)
C40.2.6-2	2. Cloudy	40 km	2 km
C40.2.6-3	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.2.6-4	c. Vertical Cell Size	0.1 cm	5 cm
C40.2.6-5	d. Vertical Reporting Interval	N/A (single value reported)	5 cm
C40.2.6-6	e. Horizontal Coverage	Land	Land
C40.2.6-7	f. Vertical Coverage (TBR)	Surface to -0.1 cm (skin layer)	Surface to -80 cm
C40.2.6-8	g. Measurement Range	0 - 100 cm/m (TBR)	0 - 100 cm/m
	h. Measurement Uncertainty		
C40.2.6-9	1. Clear, Bare soil in regions with known soil types (smaller horizontal cell size)	10 cm/m (TBR)	Surface: 1 cm/m Total 80 cm column: greater of 5 % or 0.013 cm/m (130 g/m^3)
C40.2.6-10	2. Cloudy , Bare soil in regions with known soil types (greater horizontal cell size)	20 cm/m (TBR)	Surface: 1 cm/m Total 80 cm column: greater of 5 % or 0.013 cm/m (130 g/m^3)
C40.2.6-11	i. Mapping Uncertainty	3 km	1 km
C40.2.6-12	j. Swath Width	1700 km (TBR)	(TBD)

Precipitable Water **TRD App D Section 40.3.3**

The requirements below apply under both clear and cloudy conditions. Precipitable water is defined as the total equivalent water in a vertical column of the atmosphere per unit cross-sectional area.

Para. No.		Thresholds	Objectives
C40.3.3-1	a. Horizontal Cell Size	25 km (TBR)	1 km
C40.3.3-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.3.3-3	c. Horizontal Coverage	Global	Global
C40.3.3-4	d. Measurement Range	0 - 75 mm	0 - 100 mm
C40.3.3-5	e. Measurement Accuracy	Greater of 10 % or 2 mm	1 mm
C40.3.3-6	f. Measurement Precision	1 mm	1 mm
C40.3.3-7	g. Mapping Uncertainty	3 km	0.1 km
C40.3.3-8	h. Swath Width	1700 km (TBR)	(TBD)

Precipitation (Type, Rate) **TRD App D Section 40.3.4**

The required data products are precipitation rate and identification of type as rain or ice. The requirements in the table below apply under both clear and cloudy conditions.

Para. No.		Thresholds	Objectives
C40.3.4-1	a. Horizontal Cell Size	15 km (TBR)	0.1 km
C40.3.4-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.3.4-3	c. Horizontal Coverage	Global	Global
	d. Measurement Range		
C40.3.4-4	1. Precipitation Rate	0 - 50 (TBR) mm/hr	0 - 250 mm/hr
C40.3.4-5	2. Precipitation Type	Rain and ice	Rain and ice
C40.3.4-6	e. Measurement Accuracy, Precip. Rate	2 mm/hr	2 mm/hr
C40.3.4-7	f. Measurement Precision, Precip. Rate	1 mm/hr	1 mm/hr
C40.3.4-8	g. Correct Typing Probability, Precip. Type	(TBD) %	(TBD) %
C40.3.4-9	h. Mapping Uncertainty	3 km	0.1 km
C40.3.4-10	i. Swath Width	1700 km (TBR)	(TBD)

Pressure Profile (TBR) **TRD App D Section 40.3.5**

A pressure profile is a set of estimates of the atmospheric pressure at specified altitudes above the Earth's surface. The requirements below apply under both clear and cloudy conditions.

Para. No.		Thresholds	Objectives
C40.3.5-1	a. Horizontal Cell Size	25 km	5 km
C40.3.5-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.3.5-3	c. Vertical Cell Size	1 km	0 km
	d. Vertical Reporting Interval		
C40.3.5-4	1. 0 - 2 km	1 km	0.25 km
C40.3.5-5	2. 2 - 5 km	1 km	0.5 km
C40.3.5-6	3. > 5 km	1 km	1 km
C40.3.5-7	e. Horizontal Coverage	Global	Global
C40.3.5-8	f. Vertical Coverage	0 - 30 km	0 - 30 km
C40.3.5-9	g. Measurement Range	10 - 1050 mb	10 - 1050 mb
	h. Measurement Accuracy		
C40.3.5-11	1. 0 - 10 km	5 % (TBR)	3 % (TBR)
C40.3.5-12	2. 10 - 30 km	10 % (TBR)	5 %
C40.3.5-13	i. Measurement Precision	4 mb	2 mb
C40.3.5-14	j. Mapping Uncertainty	7 km	1 km
C40.3.5-15	k. Swath Width	1700 km (TBR)	(TBD)

Total Water Content **TRD App D Section 40.3.6**

Total water content is defined as the water vapor, cloud liquid water, and cloud ice liquid equivalent in specified segments of a vertical column of the atmosphere. For this EDR vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud liquid water must be reported. The requirements below apply under both clear and cloudy conditions.

Para. No.		Thresholds	Objectives
C40.3.6-1	a. Horizontal Cell Size	20 km	10 km
C40.3.6-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.3.6-3	c. Vertical Cell Size (TBR)	3 km	1 km
C40.3.6-4	d. Vertical Reporting Interval	Vertical cell size	Vertical cell size
C40.3.6-5	e. Horizontal Coverage	Global	Global
C40.3.6-6	f. Vertical Coverage	0 - 20 km	0 - (TBD) km
C40.3.6-7	g. Measurement Range	0 - 200 kg/m² (TBR)	(TBD)
	h. Measurement Uncertainty		
C40.3.6-8	1. Point Measurement	2 kg/m^2	(TBD)
C40.3.6-9	2. Global Average	1 kg/m^2(TBR)	(TBD)
C40.3.6-10	i. Mapping Uncertainty	7 km	7 km
C40.3.6-11	j. Swath Width	1700 km (TBR)	3000 km (TBR)

Cloud Base Height (TBR) **TRD App D Section 40.4.1**

Cloud base height is defined as the height above ground level where cloud bases occur. More precisely, for a cloud covered Earth location, cloud base height is the set of altitudes of the bases of the clouds that intersect the local vertical at this location. The reported heights are horizontal spatial averages over a cell, i.e., a square region of the Earth's surface. If a cloud layer does not extend over an entire cell, the spatial average is limited to the portion of the cell that is covered by the layer. As a threshold, only the height of the base of the lowest altitude cloud layer is required and objective is to report cloud base height for all distinct cloud layers.

Para. No.		Thresholds	Objectives
C40.4.1-1	a. Horizontal Cell Size	25 km	10 km
C40.4.1-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.4.1-3	c. Horizontal Coverage	Global	Global
	d. Vertical Cell Size	N/A	N/A
C40.4.1-4	e. Vertical Reporting Interval	Base of lowest cloud layer	Base of all distinct cloud layers
C40.4.1-5	f. Measurement Range	0 - 15 km	0 - 30 km
C40.4.1-6	g. Measurement Uncertainty	2 km	0.25 km
C40.4.1-7	h. Mapping Uncertainty	5 km	1 km
C40.4.1-8	i. Swath Width	1700 km (TBR)	3000 km (TBR)

Cloud Ice Water Path **TRD App D Section 40.4.4**

Cloud ice water path is defined as the equivalent amount of water within cloud ice particles in a specified segment of a vertical column of the atmosphere. For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud ice water path must be reported.

Para. No.		Thresholds	Objectives
C40.4.4-1	a. Horizontal Cell Size	50 km	10 km
C40.4.4-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.4.4-3	c. Vertical Cell Size	N/A (Total Column)	0.3 km
C40.4.4-4	d. Vertical Reporting Interval	N/A (Total Column)	0.3 km
C40.4.4-5	e. Horizontal Coverage	Global	Global
C40.4.4-6	f. Vertical Coverage	N/A (Total Column)	0 - 20 km
C40.4.4-7	g. Measurement Range	0 - 2.6 kg/m^2 (TBR)	0 - 10 kg/m^2
C40.4.4-8	h. Measurement Accuracy	10 % or 5 g/m^2 (TBR)	5 %
C40.4.4-9	i. Measurement Precision	5 %	2 %
C40.4.4-10	j. Long Term Stability	2 %	1 %
C40.4.4-11	k. Mapping Uncertainty	4 km	1 km
C40.4.4-12	l. Swath Width	1700 km (TBR)	3000 km (TBR)

Cloud Liquid Water **TRD App D Section 40.4.5**

Cloud liquid water is defined as the equivalent amount of water within cloud particles in a specified segment of a vertical column of the atmosphere. For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud liquid water must be reported.

Para. No.		Thresholds	Objectives
C40.4.5-1	a. Horizontal Cell Size	20 km	5 km
C40.4.5-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.4.5-3	c. Vertical Cell Size	N/A (Total Column)	0.3 km
C40.4.5-4	d. Vertical Reporting Interval	N/A (Total Column)	0.3 km
C40.4.5-5	e. Horizontal Coverage	Global	Global
C40.4.5-6	f. Vertical Coverage	N/A (Total Column)	0 - 30 km
C40.4.5-7	g. Measurement Range	0 - 5 kg/m^2	(TBD)
	h. Measurement Uncertainty		
C40.4.5-8	1. Over ocean	0.25 kg/m^2	0.01 kg/m^2
C40.4.5-9	2. Over land	0.5 kg/m^2	0.01 kg/m^2
C40.4.5-10	i. Mapping Uncertainty	7 km	1 km
C40.4.5-11	j. Swath Width	1700 km (TBR)	3000 km (TBR)

Snow Cover/Depth **TRD App D Section 40.6.3**

Horizontal and vertical extent of snow cover. As a threshold, only the fraction of snow cover in the specified horizontal cell (clear or cloudy) is required, regardless of depth. As an objective, fraction of snow cover for snow having a specified minimum depth is required in the specified horizontal cell (clear or cloudy) for a set of specified minimum depths.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size (TBR)		
C40.6.3-1	1. Clear - daytime	12.5 km	1 km
C40.6.3-2	2. Cloudy and/or nighttime	12.5 km	1 km
C40.6.3-3	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.6.3-4	c. Snow Depth Ranges	> 0 cm (Any Snow Thickness)	> 8 cm, > 15 cm, > 30 cm, >51 cm, >76 cm
C40.6.3-5	d. Horizontal Coverage	Land	Land & Ice
C40.6.3-6	e. Vertical Coverage	0 - 40 cm	0 - 1 m
C40.6.3-7	f. Measurement Range	0 - 1 per snow depth category	0 - 1 per snow depth category
	g. Measurement Uncertainty (TBR)		
C40.6.3-8	1. Clear - daytime	10 % (snow/no snow)	10 % for snow depth
C40.6.3-9	2. Cloudy and/or nighttime	20 % (snow/no snow)	(TBD)
	h. Mapping Uncertainty		
C40.6.3-10	1. Clear	2 km	1 km
C40.6.3-11	2. Cloudy	7 km	1 km
C40.6.3-12	k. Swath Width	1700 km (TBR)	(TBD)

Fresh Water Ice **TRD App D Section 40.7.2**

Fresh water ice concentration is defined as the fraction of a given area of fresh water that is covered by ice, quantized to the nearest one tenth. Ice edge boundary is the contour separating fresh water from fresh water ice. The error in ice edge boundary location is defined as the distance between a measured boundary point and the nearest point on the true ice edge boundary. The measurement uncertainty requirement on ice edge boundary limits this error.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
C40.7.2-1	1. Regional, nadir	20 km (TBR)	(TBD)
C40.7.2-2	2. Regional, worst case	20 km (TBR)	(TBD) 0.65 km
C40.7.2-3	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.7.2-4	c. Horizontal Coverage	Fresh Water Up to 1/2 orbit, non-contiguous, commandable by SOC	Fresh Water Up to 1/2 orbit, non-contiguous, commandable by SOC
C40.7.2-5	d. Measurement Range	1/10 to 10/10 concentration	0/10 to 10/10 concentration
C40.7.2-6	e. Measurement Uncertainty		
C40.7.2-7	1. Ice Edge Boundary	10 km	5 km
C40.7.2-8	2. Ice Concentration	20 % or 1/10	10 %
C40.7.2-9	f. Mapping Uncertainty	3 km	1 km
C40.7.2-10	g. Swath Width	1700 km (TBR)	(TBD)

Ice Surface Temperature **TRD App D Section 40.7.3**

This EDR is required under clear and cloudy conditions. As a threshold, the temperature of the surface of ice over land or water is required. The objective is to measure the atmospheric temperature 2 m above the surface of the ice.

Para. No.		Thresholds	Objectives
C40.7.3-1	a. Horizontal Cell Size	30 km	10 km
C40.7.3-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.7.3-3	c. Horizontal Coverage	Ice-covered land/water	Ice-covered land/water
C40.7.3-4	d. Measurement Range	213 K - 293 K	(TBD)
C40.7.3-5	e. Measurement Uncertainty	1 K	(TBD)
C40.7.3-6	f. Mapping Uncertainty	3 km	1 km
C40.7.3-7	g. Swath Width	1700 km (TBR)	(TBD)

Sea Ice Age and Sea Ice Edge Motion **TRD App D Section 40.7.8**

The requirements below apply under both clear and cloudy conditions. Sea ice age is defined as the time that has passed since the formation of the surface layer of an ice covered region of the ocean. The content of the sea ice age EDR is the typing of areas of sea ice by age. Sea ice motion is defined as the displacement of a sea ice edge. Definitions of the Ice Age Classes are (TBS).

Para. No.		Thresholds	Objectives
C40.7.8-1	a. Horizontal Cell Size (Ice Age)	20 km	0.1 km
C40.7.8-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.7.8-3	c. Horizontal Coverage	Oceans	Oceans
	d. Measurement Range		
C40.7.8-4	1. Ice Age Classes	First Year, Multi-year (TBR)	New, Young, First Year, and Old (TBR)
C40.7.8-5	2. Ice Motion	0-50 km/day (TBR)	0 - 50 km/day
C40.7.8-6	e. Probability of Correct Typing (Ice Age)	70 %	90 %
C40.7.8-7	f. Measurement Uncertainty (Ice motion)	1 km/day	0.1 km/day
C40.7.8-8	g. Mapping Uncertainty	3 km (TBR)	1 km
C40.7.8-9	h. Swath Width	1700 km (TBR)	(TBD)

Surface Wind Stress (TBR) **TRD App D Section 40.7.10**

The requirements below apply under both clear and cloudy conditions. Surface wind stress is defined as the magnitude of the frictional stress of the wind acting on the sea surface, causing it to move as a wind-drift current, and causing the formation of waves.

Para. No.		Thresholds	Objectives
C40.7.10-1	a. Horizontal Cell Size	50 km	20 km
C40.7.10-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.7.10-3	c. Horizontal Coverage	Oceans	Oceans
C40.7.10-4	d. Measurement Range	0 - 50 N/m^2 (TBR)	0 - 50 N/m^2 (TBR)
C40.7.10-5	e. Measurement Accuracy	2 N/m^2	1 N/m^2
C40.7.10-6	f. Measurement Precision	2 N/m^2	1 N/m^2
C40.7.10-7	g. Mapping Uncertainty	7 km	1 km (TBR)
C40.7.10-8	i. Swath Width	1700 km (TBR)	(TBD)

Land Surface Temperature **TRD App D Section 40.6.1**

Land surface temperature (LST) is defined as the skin temperature of the uppermost layer of the land surface.

Para. No.		Thresholds	Objectives
C40.6.1-1	a. Horizontal Cell Size	50 km (TBR)	1 km
C40.6.1-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.6.1-3	c. Horizontal Coverage	Land	Land
C40.6.1-4	d. Measurement Range	213 K - 343 K	213 K - 343 K
C40.6.1-5	e. Measurement Accuracy	2.5 K	1 K
C40.6.1-6	f. Measurement Precision	0.5 K	0.025 K
C40.6.1-7	g. Mapping Uncertainty	5 km	1 km
C40.6.1-8	h. Swath Width	1700 km (TBR)	(TBD)

Vegetation/Surface Type **TRD App D Section 40.6.4**

Vegetation/surface type is defined as the predominant vegetation and/or soil type in a given area.

SRDC3.2.1.1.1.1-6

Each given area shall be classified as one of the following 21 types: crop land, brush/scrub, coniferous forest, deciduous forest, tropical forest, grassland, swamp, marsh/bog, flooded land, loam, sandy soil, clay, peat, gravel, desert, water, snow/ice, urban/developed, rocky fields, tundra, and savannah. Estimation of the percentage of vegetation cover per type in each cell is an objective.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
C40.6.4-1	1. Global	20 km	1 km
C40.6.4-2	2. Regional	20 km	0.25 km
C40.6.4-3	b. Horizontal Reporting Interval	(TBD)	(TBD)
	c. Horizontal Coverage		
C40.6.4-4	1. Global	Land	Land
C40.6.4-5	2. Regional	Land, up to 1/2 orbit, non-contiguous, commandable by SOC	Land, up to 1/2 orbit, non-contiguous, commandable by SOC
	d. Measurement Range		
C40.6.4-6	1. Vegetation/surface type	21 types specified above	21 types specified above
C40.6.4-7	2. Vegetation cover	N/A	0 - 100 %
C40.6.4-8	e. Measurement Accuracy (veg. cover)	N/A	2 %
C40.6.4-9	f. Measurement Precision (veg. cover)	N/A	0.1 %
C40.6.4-10	g. Correct Typing Probability (vegetation /surface type)	70 %	(TBD)
C40.6.4-11	h. Mapping Uncertainty	5 km	1 km
C40.6.4-12	i. Swath Width	1700 km (TBR)	(TBD)

Secondary EDRs

The data products for Secondary EDRs have been assigned to sensors other than CMIS as Primary EDRs, but these EDRs may require CMIS data to process the associated algorithms.
(TBS)

SRDC3.2.1.1.1.1-7
The CMIS shall meet (TBS) data specifications for the generation of secondary EDRs. The CMIS contractor will be advised by the Government of CMIS data requirements identified by other NPOESS sensor contractors after award of contract, and after the other sensor vendors advise the Government of their requirements.

3.2.1.1.1.2.2 Databases and Model Computation (TBR)

SRDC3.2.1.1.1.2.2-1
The contractor shall include in his requirements flowdown analysis uncertainties in data from any databases that are relied upon in generating EDRs.

SRDC3.2.1.1.1.2.2-2
If the contractor determines that these uncertainties prevent a threshold requirement from being met, if reliance on the database is deemed necessary by the contractor, and if the database varies in time, e.g., is updated in near real time, and is not under the control of the contractor, then the contractor shall so notify the government and the government will determine the appropriate remedial action.

SRDC3.2.1.1.1.2.2-3
If a fixed database, e.g., one addressing terrain, is needed, and existing databases are not adequate to allow thresholds to be met, the contractor shall generate a new database or partial database having the characteristics necessary to demonstrate that EDR thresholds can be met.

SRDC3.2.1.1.1.2.2-4
The contractor shall identify and quantify any EDR performance degradation resulting from the lack of availability of any database or other ancillary data.

3.2.1.1.2 Sensor Data Record (SDR) Requirements (TBR)

3.2.1.1.2.1 Definition

The Sensor Data Record (SDR) is defined in Appendix A.

3.2.1.1.2.2 Requirements

SRDC3.2.1.1.2.2-1
The CMIS vendor shall provide to the Interface Data Processor Segment (IDPS) the algorithms and sensor data necessary to process TDR data into SDR data.

SRDC3.2.1.1.2.2-2
The operational SDR data shall contain as a minimum the following data and information:

- Brightness Temperature data for each channel
- Geolocation data for each sample: geodetic latitude and longitude
- Spacecraft ID tag
- CMIS sensor ID or serial number
- Flight software version number
- Orbit number
- Beginning Julian day and time tag
- Ending Julian day and time tag
- Ascending Node Julian day and time tag
- Time tag information - beginning of scan time
- Scan index

SRDC3.2.1.1.2.2-3
The CMIS contractor shall recommend additional information and data to be included in the SDR.

3.2.1.1.3 Temperature Data Record (TDR) Requirements (TBR)

3.2.1.1.3.1 Definition

The Temperature Data Record (TDR) is defined in Appendix A.

3.2.1.1.3.2 Requirements

SRDC3.2.1.1.3.2-1
The CMIS vendor shall provide to the IDPS the algorithms and sensor data necessary to process RDR data into TDR data.

SRDC3.2.1.1.3.2-2
The operational TDR data shall contain as a minimum the following data and information:

- Antenna Temperature data for each channel and sample
- Sensor health and status data: limited to that necessary to assess performance and compute Sensitivity
- Sensor calibration data
- Spacecraft ID tag
- CMIS sensor ID or serial number
- Flight software version number
- Orbit number
- Beginning Julian day and time tag
- Ending Julian day and time tag
- Ascending Node Julian day and time tag
- Satellite Ephemeris data: sufficient to geolocate each data sample

Time tag information - beginning of scan time
Scan index

SRDC3.2.1.1.3.2-3
The CMIS contractor shall recommend additional information and data to be included in the TDR.

3.2.1.1.4 Raw Data Record (RDR) Requirements (TBR)

3.2.1.1.4.1 Definition

The RDR is defined in Appendix A.
Because RDRs are processed into EDRs, RDRs are considered to have met their requirements when they are of an appropriate format and quality to be adequately processed into their associated EDRs.

3.2.1.1.4.2 Requirements

SRDC3.2.1.1.4.2-1
The RDR shall, as a minimum, consist of the following information:

Raw data counts for each CMIS channel
Spacecraft ID tag
CMIS sensor ID or serial number
Flight software version number
Orbit number
Beginning Julian day and time tag
Ending Julian day and time tag
Ascending Node Julian day and time tag
Satellite Ephemeris data: sufficient to geolocate each data sample
Time tag information - beginning of scan time
Scan index number
Sensor calibration data
Sensor health and status data: limited to that necessary to assess performance and compute Sensitivity
CMIS mounting offset angles - needed for geolocation

SRDC3.2.1.1.4.2-2
The CMIS contractor shall recommend additional information and data to be included in the RDR.

3.2.1.1.5 Algorithms

SRDC3.2.1.1.5-1
EDR scientific algorithms shall be provided by the CMIS contractor.

SRDC3.2.1.1.5-2
The CMIS scientific algorithms shall provide EDRs which satisfy the NPOESS requirements as specified in Section 3.2.1.1.1.1. Scientific algorithms may also be recommended by the government's Operational Algorithm Teams (OATs).

SRDC3.2.1.1.5-3
The contractor shall identify the use of all non-CMIS data required for algorithm processing.

SRDC3.2.1.1.5-4
The Contractor shall provide an Algorithm Theoretical Basis Document (ATBD) for the assigned set of Primary EDRs. ATBDs provide the physical theory and assumptions behind the EDRs, as well as the mathematical procedures required to produce the RDRs, convert the RDRs into the SDRs, and convert the SDRs into the EDRs. The ATBD should discuss limitations on the approach, accuracy considerations, additional information required for measurement processing (mandatory and desirable), and alternative processing approaches required under alternative measurement situations (e.g., daytime and nighttime observations).

SRDC3.2.1.1.5-5
The Contractor shall provide research grade source code implementing the algorithm(s) described in the ATBD that address the primary EDRs. The research grade code should include all processes, other than input/output, needed to: convert RDRs into SDRs; convert SDRs into EDRs; use all mandatory outside data; use any optional outside data, if available; select alternative processing algorithms based on the data available; provide continuing calibration validation; and any other similar processing tasks required to satisfy allocated EDR quality and availability requirements. The scientific algorithms provided by the contractor may be adopted or adapted from existing algorithms, or developed, as needed.

3.2.1.1.5.1 Convertibility to Operational Algorithms

The government considers the SDR and EDR algorithms adopted, adapted, or developed by the CMIS contractor to be scientific, rather than operational, algorithms. The CMIS contractor is not responsible for identifying or developing operational SDR and EDR algorithms for the CMIS. (Any operational algorithms necessary for the generation of RDRs will ultimately be the responsibility of the CMIS contractor, and the operational software implementing these algorithms will be part of the required flight software. This statement applies to the post-downselect phase of the CMIS program.)

SRDC3.2.1.1.5.1-1
The scientific SDR and EDR algorithms delivered by the CMIS contractor shall be convertible into operational software that is compatible with a 20 minute maximum processing time at either the DoD Centrals or DoD field terminals for the conversion of all pertinent RDRs into all required EDRs for the site or terminal, including those based wholly or in part on data from other sensor suites. The intent of this requirement is to preclude algorithms that are so computationally intensive that any foreseeable

implementation would stress or exceed the time available for delivery of EDRs in an operational environment.

SRDC3.2.1.1.5.1-2
The means by which the contractor shall validate the requirement that scientific algorithms be convertible to operational software, subject to the processing time constraint specified in this Section, is (**TBD**).

SRDC3.2.1.1.5.1-3
The availability of any inputs required, from databases or non-CMIS data sources, to generate EDRs shall be sufficient to allow EDRs to be generated at the DoD Centrals and DoD field terminals within the time constraint specified in this Section.

3.2.1.1.5.2 Performance Requirements

SRDC3.2.1.1.5.2-1
The performance of the CMIS science algorithms delivered by the CMIS contractor shall meet EDR thresholds.

SRDC3.2.1.1.5.2-2
The performance of the CMIS science algorithms shall be no worse than the performance of algorithms utilized for current operational data products for these EDRs, if such operational products exist (TBR).

3.2.1.2 CMIS Channels

3.2.1.2.1 Definition

A sensor channel is determined by the pass-band frequencies, bandwidths and polarization characteristics of the measurements.

3.2.1.2.2 Number of Channels

SRDC3.2.1.2.2-1
The number of channels shall be sufficient to satisfy the EDR requirements assigned to CMIS.

3.2.1.3 CMIS Frequency Bands

3.2.1.3.1 Use Of Allocated Frequency Bands

To reduce the possibility of interference from other communication/radio services, the CMIS should use frequency bands which correspond to the international allocations for Earth Exploration-Satellite and are reserved for such usage.

SRDC3.2.1.3.1-1
Utilization of other frequency bands shall be justified by analysis(es) showing significant performance and/or cost advantages.

SRDC3.2.1.3.1-2
An attempt shall be made to utilize frequency bands having the minimum possible risk of interference from other allocated radio services.

SRDC3.2.1.3.1-3
All frequency bands utilized by the CMIS shall be approved by the government. Exceptions to this are noted in Section 3.2.1.3.2.
The frequencies listed in Table 3.2.1.3.1 are based on current (time of writing) NTIA allocations and are subject to change. The contractor should verify, in conjunction with the Government, the accuracy of this table and the applicability of the frequency allocations for the time period when CMIS is planned to be operational.

TABLE 3.2.1.3.1 FREQUENCY ALLOCATIONS FOR REMOTE SENSING

This table contains a summary of frequency band allocations involving the Earth Exploration-Satellite service (passive sensing).

Frequency band (GHz)		**Allocation**	**Notes:**
1.37	1.40	Secondary	
1.4	1.427	Exclusive	
2.69	2.70	Exclusive with exceptions	1. Some pre-existing radio services (prior to 1/1/1985) protected as primary users within Region 1
2.64	2.655	Secondary	
4.95	4.99	Secondary	
6.8		Not allocated for passive sensing	
10.6	10.7	Shared	2. The portion 10.6-10.68 GHz is exclusive passive in U.S. only; internationally, this band is shared with Fixed, and Mobile services, usually with power restrictions. Aeronautical service within this band discouraged.
15.20	15.35	Secondary	
15.35	15.4	Exclusive	3. Some fixed and mobile services provided for, internationally, on a secondary basis.
18.6	18.8	Shared	4. The band 18.6 to 18.8 GHz is allocated to passive services as a shared user in Region 2, and secondary user in Regions 1 and 3, shared with Fixed and Fixed Satellite to Earth. Non-government primary allocation to Fixed. Users encouraged to limit, as much as practical, their power flux density at the Earth's surface.
21.20	21.40	Exclusive	
22.21	22.5	Shared	5. The band 22.21 - 22.5 GHz is shared with fixed, and mobile services. Administrators are encouraged to take all practical steps to protect the radio astronomy service. However, passive services can not impose constraints upon the fixed or mobile services except for aeronautical mobile.
23.60	24.0	Exclusive	
31.3	31.5	Exclusive	
31.5	31.8	Shared	6. The band 31.5 - 31.8 GHz is allocated exclusively for passive sensing in the U.S. However, 31.5 - 31.8 GHz is shared with Fixed and Mobile in Regions 1 and 3. Within Regions 1 and 3, administrators are encouraged to limit frequency assignments that would cause harmful interference to passive sensing.
36.0	37.0	Shared	7. The band 36.0 - 37.0 GHz is shared with Fixed and Mobile

Frequency band (GHz)		Allocation	Notes:
			services. Administrators are encouraged to take all practical steps to protect the spectral line observations of the radio astronomy service in the band 36.43 - 36.5 GHz.
50.2	50.4	Shared	
50.4	51.4	Not allocated for passive sensing	8. The band 50.4 - 51.4 GHz is allocated to Fixed, Fixed-Satellite (Earth-to-Space), Mobile, and Mobile Satellite (Earth-to-Space).
51.4	54.25	Exclusive	
54.25	58.0	Shared	9. The band 54.25 - 58.0 GHz is allocated for passive sensing, shared with Fixed, Intersatellite, and Mobile (including aeronautical mobile). In a few countries this band is allocated to Radiolocation on a primary basis.
58.2	59.0	Exclusive	
59.0	64.0	Not allocated for passive sensing	10. The band 59.0 - 64.0 GHz is allocated for Intersatellite communications. (This band may be re-allocated.)
64.0	65.0	Exclusive	
65.0	66.0	Shared	11. The band 65.0 - 66.0 GHz is allocated for passive sensing, to be shared with the Fixed and Mobile services.
86.0	92.0	Exclusive	
92.0	95.0	Not allocated for passive sensing	12. The band 92.0 - 95.0 GHz is allocated to Fixed, Fixed-Satellite (Earth-to-Space), Mobile, and Radiolocation
100.0	102.0	Shared	13. The band 100.0 - 102.0 GHz is allocated passive, shared with Fixed, and Mobile.
105.0	116.0	Exclusive	
116.0	126.0	Shared	14. The band 116.0 - 126.0 GHz is allocated to passive, shared with Fixed, Intersatellite, and Mobile.
150.0	151.0	Shared	15. The bands 150.0 - 151.0 GHz and 174.5 - 176.5 GHz are allocated primary to passive, shared with Fixed, Fixed-Satellite (Space-to-Earth), and Mobile.
164.0	168.0	Exclusive	
174.5	176.5	Shared	15. The bands 150.0 - 151.0 GHz and 174.5 - 176.5 GHz are allocated primary to passive, shared with Fixed, Fixed-Satellite (Space-to-Earth), and Mobile.
182.0	185.0	Exclusive	
200.0	202.0	Shared	16. The band 200.0 - 202.0 GHz is allocated to passive, shared with Fixed, and Mobile.
217.0	231.0	Exclusive	
235.0	238.0	Shared	17. The band 235.0 - 238.0 GHz is allocated to passive, shared with Fixed, Fixed-Satellite (Space-to-Earth), and Mobile.
250.0	252.0	Exclusive	

Note: There are no allocations above 300 GHz.

SRDC3.2.1.3.1-4
The contractor shall utilize the most up-to-date information as it becomes available. (Reference Document: Manual of Regulations and Procedures for Federal Radio Frequency Management, Sept. 1995.)
Note that the specific frequencies and polarizations required by the CMIS are determined by the CMIS contractor as part of their design analysis and subject to the constraints discussed in this section.

SRDC3.2.1.3.1-5
The final choices for the CMIS frequency bands shall depend not only on the frequency allocations, but on phenomenological and radiometric considerations, and the necessity of meeting the EDR performance requirements in Section 3.2.1.1.1.1.

3.2.1.3.2 CMIS Frequency Bands: Exceptions

This section lists specific exceptions to the use of exclusive allocations discussed in Section 3.2.1.3.1. The CMIS contractor is not required to make use of these exceptions.

3.2.1.3.2.1 The 183 GHz Water Vapor Band (TBR)

SRDC3.2.1.3.2.1-1
Due to its heritage and recognized utility for water vapor remote sensing, the CMIS contractor shall be allowed to utilize the band in the frequency range:

$$f_{center} = [183.310 - (\textbf{TBD}), 183.310 + (\textbf{TBD})] \text{ GHz.}$$

3.2.1.3.2.2 Additional Exceptions

Additional Exceptions are (**TBD**).

3.2.1.4 Sensitivity

3.2.1.4.1 Definition

The end-to-end radiometric sensitivity is the change in Brightness Temperature of the incident radiation at the collecting aperture required to change the mean value of the measured Brightness Temperature by one standard deviation at the digitized output of the radiometer when sampled at the rate determined by the pre-sampling filter. This is denoted as δT_{rms} and also referred to as Noise-Equivalent Temperature Difference (NEDT). Units are Kelvin.

3.2.1.4.2 Requirement

SRDC3.2.1.4.2-1
The δT_{rms} value shall be consistent with meeting all of the CMIS EDR requirements and the requirements for radiometric accuracy.

SRDC3.2.1.4.2-2
An error analysis/budget for the CMIS pre-launch and on-orbit NEDT, which includes all relevant noise sources, shall be provided to the Government.

SRDC3.2.1.4.2-3
The sensitivity of each CMIS channel shall be measured over the range of scene Brightness Temperatures of (TBD) to (TBD).

3.2.1.5 Measurement Accuracy

3.2.1.5.1 Absolute Radiometric Accuracy

3.2.1.5.1.1 Definition

The absolute radiometric accuracy, for each CMIS channel, is defined as the difference between the brightness temperature values as measured by the CMIS when compared to a standard calibration target. The conditions under which these measurements are performed are (TBD). The units are Kelvin.

SRDC3.2.1.5.1.1-1
The absolute accuracy of the CMIS channels shall be determined by the ability to correctly measure the brightness temperature of an external calibration target having an emissivity consistent with the calibration target requirements in Section 3.2.1.10, over the temperature range of (TBD) K.

3.2.1.5.1.2 Requirement

SRDC3.2.1.5.1.2-1
The absolute radiometric measurement accuracy shall be consistent with meeting the CMIS EDR requirements and provide, at the SDR level, measured brightness temperatures accurate to within the errors specified in Table 3.2.1.5.1.2 over the CMIS dynamic range (see Section 3.2.1.6.3).

SRDC3.2.1.5.1.2-2
The CMIS calibration shall be traceable to a (TBD) calibration standard.

Table 3.2.1.5.1.2 Measurement Accuracy Requirements for each channel.

(TBD)

3.2.1.5.2 Interchannel Accuracy (TBR)

SRDC3.2.1.5.2-1
For the retrieval of certain EDRs, the relative and absolute measurement accuracy of relevant channels shall be maintained.

3.2.1.5.2.1 Definition

The interchannel accuracy is defined as the difference of the measured brightness temperature of any two relevant CMIS channels, when both channels are viewing the same standard calibration target, under identical conditions.

3.2.1.5.2.2 Requirement

SRDC3.2.1.5.2.2-1
The interchannel accuracy requirements for related sounding and surface-sensing channels shall be as specified in Table 3.2.1.5.2.2.

SRDC3.2.1.5.2.2-2
These requirements shall be met in addition to the overall accuracy requirements listed in Section 3.2.1.5.1.

Table 3.2.1.5.2.2 CMIS Interchannel Accuracy Requirements

(TBD)

3.2.1.5.3 Polarimetric Channels

3.2.1.5.3.1 Definition

A polarimetric channel is defined as a channel that is intended to measure the third (T_U) or the fourth (T_V) Stokes parameter within the Earth's natural polarization basis.

The four Stokes parameters in the Earth's natural polarization basis are defined in terms of the upwelling vertically- and horizontally-polarized components of the electric fields incident on the CMIS antenna(s):

$$\mathbf{T} = [\langle E_v E_v^* \rangle,\ \langle E_h E_h^* \rangle,\ 2\mathrm{Re}\langle E_v E_h^* \rangle,\ 2\mathrm{Im}\langle E_v E_h^* \rangle]^T$$
$$= [T_v, T_h, T_U, T_V]^T$$

where: E_v and E_h are the vertically- and horizontally-polarized time-varying electric fields of the incident radiation.

3.2.1.5.3.2 Accuracy Requirement

SRDC3.2.1.5.3.2-1
The radiometric accuracy of any polarimetric channels shall be consistent with meeting relevant EDR requirements listed in Section 3.2.1.1.1.1.

SRDC3.2.1.5.3.2-2
As a minimum requirement, CMIS measurements of T_U and/or T_V shall be accurate to ± (TBD**)** K.

3.2.1.5.3.3 Unwanted Bias (TBR)

SRDC3.2.1.5.3.3-1
Data within the CMIS-supplied RDRs shall be supplied to enable removal (during ground data processing) of any biases in the measurement(s) of T_U and/or T_V caused by polarization mixing of the vertically- and/or horizontally-polarized channels.

SRDC3.2.1.5.3.3-2
The final T_U and/or T_V measurement shall meet all accuracy requirements for achieving the relevant CMIS EDRs and the accuracy requirements listed in Table 3.2.1.5.1.2 and Table 3.2.1.5.2.2.

3.2.1.6 Radiometer Transfer Function Requirements

3.2.1.6.1 Definition (TBR)

The CMIS Radiometer Transfer Function is defined as the function relating, for each CMIS channel, the digitized output from that channel to the brightness temperature incident on the CMIS aperture. The CMIS Radiometer Transfer Function characterizes the radiometric response of each CMIS channel to incident microwave radiation.

3.2.1.6.2 Linearity

SRDC3.2.1.6.2-1
The output of each CMIS channel shall be linear over the specified dynamic range (see Section 3.2.1.6.3), with respect to input brightness temperature.

SRDC3.2.1.6.2-2
Any deviation from an ideal linear system shall be less than (TBD) times the δT_{rms} sensitivity (see Section 3.2.1.4.1 for definition) value for that CMIS channel.

3.2.1.6.3 Dynamic Range

SRDC3.2.1.6.3-1
The minimum dynamic range of each CMIS channel shall be from (TBD) to (TBD) K.

SRDC3.2.1.6.3-2
The dynamic range for all channels shall be consistent with meeting all the CMIS EDR requirements specified in Section 3.2.1.1.1.1.

3.2.1.6.4 Quantization

SRDC3.2.1.6.4-1
The quantization of each CMIS channel shall be consistent with meeting both the dynamic range and EDR requirements. The quantization error is the amount that the digital quantity differs from the analog quantity.

SRDC3.2.1.6.4-2
The quantization error of each CMIS channel shall be less than (TBD) percent of the $\hat{\lambda}T_{rms}$ sensitivity (see Section 3.2.1.4.1 for definition) value for that channel.

3.2.1.6.5 RF Pass-band Characteristics

3.2.1.6.5.1 Definition (TBR)

The RF pass-band is defined as the continuous frequency band(s) between the lower and upper half-power attenuation points of the CMIS channel's transfer function.

3.2.1.6.5.2 Variability (Pass-band Ripple)

SRDC3.2.1.6.5.2-1
Within each CMIS channel pass-band(s), the gain as a function of frequency shall not change by an amount greater than (TBD) dB for channels primarily used for imaging or (TBD) dB for channels primarily used for sounding.

3.2.1.6.5.3 Center Frequency Stability

SRDC3.2.1.6.5.3-1
The center frequency of each of the individual CMIS channel pass-band(s) shall not vary by more than (TBD) percent.

3.2.1.6.6 Gain Stability

3.2.1.6.6.1 Definition (TBR)

The channel gain stability is the stability of the end-to-end radiometer gain as defined by the radiometer transfer function.

3.2.1.6.6.2 Short-term Gain Stability

SRDC3.2.1.6.6.2-1
The CMIS channel gain shall be sufficiently stable between calibrations such that the measurement accuracy, sensitivity, and EDR requirements are met.

3.2.1.6.6.3 Long-term Gain Stability

SRDC3.2.1.6.6.3-1
In no case and under no operational condition shall changes in the CMIS channel gain cause that channel to operate outside of its linear dynamic range.

3.2.1.6.6.4 Stability of Polarimetric Channels (TBR)

SRDC3.2.1.6.6.4-1
The CMIS channel gain of all polarimetric channels shall be sufficiently stable between calibrations to allow the measurements of T_U and/or T_V to meet all relevant EDR

requirements listed in Section 3.2.1.1.1.1 and accuracy requirements listed in Section 3.2.1.5.3.

3.2.1.6.7 Channel-to-Channel Isolation

3.2.1.6.7.1 Definition

Given any pair of CMIS Channels A and B, channel-to-channel isolation is defined as the input power to CMIS Channel B divided by the power that flows into CMIS Channel A from the input power into CMIS Channel B.

3.2.1.6.7.2 Requirement

SRDC3.2.1.6.7.2-1
Channel-to-channel isolation of any two CMIS channels shall be greater than or equal to (TBD) dB at any source frequency used within a CMIS channel pass-band. See Sections 3.2.1.9.1.4 and 3.2.1.9.2.3 for requirements on CMIS channels differing only by polarization characteristics.

3.2.1.6.8 Out-of-Band Rejection

3.2.1.6.8.1 Definition

Out-of-band rejection is the level of the end-to-end response of any CMIS channel to a signal within that CMIS channel pass-band divided by the level of the end-to-end response to signals outside of that CMIS channel pass-band (see Section 3.2.1.6.5 for definition of the CMIS channel pass-band).

3.2.1.6.8.2 Requirement

SRDC3.2.1.6.8.2-1
For CMIS channels primarily used for sounding, the pass-band filter(s) (either RF or IF or both) shall be such that at frequencies (TBD) times the specified half-power bandwidths away from the pass-band center(s), the filter gain will be a minimum of (TBD) dB below the band center value.

SRDC3.2.1.6.8.2-2
For CMIS channels primarily used for imaging, the requirements are (TBD) dB rejection at frequencies (TBD**)** times the specified pass-band width away from the CMIS channel center frequency.

3.2.1.7 Scan and Sampling Requirements

3.2.1.7.1 Number and Types of Scan Modes

SRDC3.2.1.7.1-1
The CMIS shall employ a conical scan mode. The conical scan geometry is shown in Figure 3.2.1.7.1. The CMIS line-of-sight (LOS) is shown by the vector **k** and is positioned at a fixed nadir angle relative to the CMIS vertical reference axis.

SRDC3.2.1.7.1-2
The CMIS nadir angle shall be (TBD) ± (TBD) degrees from the CMIS vertical reference axis. (see Sections 3.2.1.8.2 and 3.2.1.12.3).

Figure 3.2.1.7.1 CMIS Scan Geometry.

(TBS)

3.2.1.7.2 Swath Width and Field of Regard

3.2.1.7.2.1 Definitions (TBR)

The swath width is defined as the arc-length, in meters, along a segment of a great circle on the surface of the Earth, which is locally perpendicular to the satellite ground track and extends equally on either side of the ground track. The swath width is defined at the EDR level.
The CMIS sensor field of regard (FOR) is defined as the angular segment of the CMIS sensor's complete scan over which the CMIS is collecting radiance data from the Earth, and not including those angular segments used for calibration. The FOR is defined at the sensor level and is measured in degrees.

3.2.1.7.2.2 Requirement

SRDC3.2.1.7.2.2-1
The swath width shall meet all EDR requirements for the CMIS sensor suite.

SRDC3.2.1.7.2.2-2
The CMIS FOR shall be sufficient to provide all the data necessary to meet the CMIS EDR requirements.

3.2.1.7.3 CMIS Horizontal Spatial Resolution and Sampling (TBR)

3.2.1.7.3.1 CMIS Horizontal Spatial Resolution

3.2.1.7.3.1.1 Definition

The CMIS horizontal spatial resolution is defined in Appendix A.

3.2.1.7.3.1.2 Requirement

SRDC3.2.1.7.3.1.2-1
The CMIS horizontal spatial resolution shall be consistent with the CMIS EDR requirements in 3.2.1.1.1.1.

3.2.1.7.3.2 CMIS Horizontal Spatial Sampling

3.2.1.7.3.2.1 Along Scan

SRDC3.2.1.7.3.2.1-1
The spatial sampling frequency for each CMIS channel shall be consistent with Nyquist criteria in the along-scan direction to ensure that all scene spatial frequencies sensed by the CMIS antenna modulation transfer function (MTF) for that channel are undistorted and appear in the digitized output data for that channel.

SRDC3.2.1.7.3.2.1-2
An analysis shall be provided which demonstrates that this requirement is satisfied.

3.2.1.7.3.2.2 Along Track

SRDC3.2.1.7.3.2.2-1
The CMIS spatial sampling frequency in the along-track direction shall be consistent with the EDR requirements in Section 3.2.1.1.1.1.

SRDC3.2.1.7.3.2.2-2
The CMIS contractor shall assess the feasibility of and provide a recommendation to the government regarding Nyquist sampling in the along track direction.

3.2.1.7.3.3 Scan Rate

SRDC3.2.1.7.3.3-1
The scan rate for the CMIS conical scan shall be (TBD).

3.2.1.7.4 Pre-Sampling Filter Characteristics

SRDC3.2.1.7.4-1
The bandpass characteristics of the pre-sampling filter shall be sufficient to pass all spatial frequencies sensed by the antenna modulation transfer function without introducing distortion greater than (TBD) percent and to provide an effective integration time to meet the EDR requirements and CMIS sensor specifications for measurement sensitivity (see Section 3.2.1.4), accuracy (see Section 3.2.1.5), and horizontal spatial resolution (see Section 3.2.1.7.3).

SRDC3.2.1.7.4-2
An analysis shall be provided which demonstrates that this requirement is satisfied.

3.2.1.7.5 Scan Position Knowledge

SRDC3.2.1.7.5-1
The CMIS shall provide a measurement and readout capability to determine the angular position of the CMIS LOS in the azimuth direction relative to the satellite velocity vector.

SRDC3.2.1.7.5-2
The scan position knowledge measurement shall be accurate to (TBD) degrees and consistent with the CMIS Earth location and EDR requirements.

3.2.1.8 Antenna Requirements

3.2.1.8.1 Antenna Beam Characteristics

The antenna beam characteristics are described in terms of the Half Power Beam Width (HPBW), the main beam efficiency, pattern uniformity, and the maximum sidelobe level.

Table 3.2.1.8.1 Antenna Beam Characteristics

(TBD**)**

3.2.1.8.1.1 Antenna Half Power Beam Width

3.2.1.8.1.1.1 Definitions

The HPBW is the angular width between the two directions at which the main beam gain function is one-half its maximum value within a plane containing the maximum gain of the main beam lobe.
The CMIS channel HPBW is defined by the average of the two HPBW values measured in the planes containing the along-track and along-scan directions relative to the CMIS LOS and averaged over the CMIS channel pass-band.

3.2.1.8.1.1.2 Requirement

SRDC3.2.1.8.1.1.2-1
The individual CMIS channel HPBW values shall be sufficient to meet the EDR requirements listed in Section 3.2.1.1.1.1.

SRDC3.2.1.8.1.1.2-2
As a minimum, the HPBW requirements in Table 3.2.1.8.1 shall be met.

3.2.1.8.1.2 Main Beam Efficiency

3.2.1.8.1.2.1 Definition

The main beam efficiency of each CMIS channel is defined as the ratio of energy received in the desired polarization over the CMIS channel pass-band (for pass-band definition see Section 3.2.1.6.5.1) within 2.5 times the CMIS channel HPBW to the total amount of energy received by the antenna within the CMIS channel pass-band.

3.2.1.8.1.2.2 Requirements (TBR)

SRDC3.2.1.8.1.2.2-1
An error analysis/budget for the CMIS main beam efficiencies of all channels, which includes all relevant error sources, shall be provided to the Government.

SRDC3.2.1.8.1.2.2-2
The main beam efficiency shall be no less than the values listed in Table 3.2.1.8.1 (see section 3.2.1.8.1.4). In addition, the following requirements apply:

SRDC3.2.1.8.1.2.2-3
For all CMIS channels having a center frequency less than 12 GHz, the main beam efficiency shall be no less than 92% (TBR).

SRDC3.2.1.8.1.2.2-4
For all CMIS channels having a center frequency greater than or equal to 12 GHz, the main beam efficiency shall be no less than 95% (TBR).

SRDC3.2.1.8.1.2.2-5
For all CMIS channels primarily used for sounding, the main beam efficiency shall be no less than 95% (TBR).

3.2.1.8.1.3 Antenna Beam Uniformity

SRDC3.2.1.8.1.3-1
The HPBW in any plane containing the antenna main beam maximum gain for a given CMIS channel shall be within (TBD) percent of the CMIS channel HPBW (Section 3.2.1.8.1.1.1).

3.2.1.8.1.4 Maximum Relative Sidelobe Level (TBR)

3.2.1.8.1.4.1 Definition

The maximum relative sidelobe level is defined as the maximum value of the antenna gain function within any antenna sidelobe averaged over the CMIS channel pass-band, with respect to the maximum antenna gain averaged over the CMIS channel pass-band.

3.2.1.8.1.4.2 Requirement

SRDC3.2.1.8.1.4.2-1
The maximum relative sidelobe levels for each CMIS channel shall not be greater than the values listed in Table 3.2.1.8.1.

3.2.1.8.2 Beam Alignment (TBR)

The CMIS channel line-of-sight (LOS) vector is defined by the weighted center of the CMIS channel antenna beam's half power contour (in the CMIS sensor reference frame) averaged over the CMIS channel pass-band.

SRDC3.2.1.8.2-1
An error analysis/budget for the CMIS beam pointing accuracy and knowledge, which includes all relevant error sources, shall be provided.

3.2.1.8.2.1 Beam Pointing Accuracy

3.2.1.8.2.1.1 Along-track Requirement

SRDC3.2.1.8.2.1.1-1
The CMIS shall provide a LOS depression angle of (TBD) (TBD) degrees relative to the CMIS vertical reference axis (see Section 3.2.1.12.3).

SRDC3.2.1.8.2.1.1-2
The absolute along-track beam pointing error relative to the CMIS line-of-sight shall be less than or equal to ±(TBD) degrees.

3.2.1.8.2.1.2 Along-scan Requirement

SRDC3.2.1.8.2.1.2-1
The absolute, along-scan beam pointing error relative to the CMIS line-of-sight shall be less than or equal to ±(TBD) degrees.

3.2.1.8.2.2 Beam Pointing Knowledge

3.2.1.8.2.2.1 Absolute Beam Pointing Knowledge

SRDC3.2.1.8.2.2.1-1
The absolute beam pointing knowledge of each CMIS channel, with respect to the CMIS sensor reference axes, shall be less than or equal to (TBD) degrees or (TBD) percent of the antenna pattern HPBW whichever is smaller in both the along-track and along-scan directions.

3.2.1.8.2.2.2 Relative Beam Pointing Knowledge

SRDC3.2.1.8.2.2.2-1
The relative beam pointing knowledge of each CMIS channel shall be less than or equal to (TBD) degrees or (TBD) percent of the antenna pattern HPBW whichever is smaller for all relative measurements in both the along-track and along-scan directions.

3.2.1.8.2.3 Beam Co-registration (TBR)

SRDC3.2.1.8.2.3-1
Unless otherwise specified, the relative channel-to-channel beam pointing error shall be referenced to the (TBD) GHz channel antenna beam pattern centroid. At present the

government is considering that the reference channel will be one of the high spatial resolution imaging channels. This will aid in the validation of beam pointing and co-registration.

SRDC3.2.1.8.2.3-2
The absolute beam pointing error shall not exceed (TBD) degrees or (TBD) percent of the co-registered channel's HPBW, whichever is smaller. However, fixed beam offsets may be utilized (multiple beams), as required, in order to meet the EDR requirements (see Section 3.2.1.8.2.4).

3.2.1.8.2.4 Individual Beam Offsets

Antenna beams having fixed angular offsets from the reference channel antenna beam are allowed, as required, to meet EDR requirements (while still meeting the beam pointing knowledge requirements in section 3.2.1.8.2.2).

SRDC3.2.1.8.2.4-1
The fixed angular offset relative to the reference channel antenna beam shall be maintained to within (TBD) degrees.

3.2.1.8.2.5 Maximum Allowed Beam Alignment Change (TBR)

SRDC3.2.1.8.2.5-1
The maximum allowed antenna beam alignment change shall be less than (TBD) degrees or (TBD) percent of the CMIS channel HPBW.

3.2.1.9 Polarization Requirements (TBR)

3.2.1.9.1 Antenna Polarization Characteristics for Non-Polarimetric Channels

3.2.1.9.1.1 Definitions

The horizontal and vertical polarization vectors are defined by Equations 3-1 and 3-2 (respectively) and are shown in Figure 3.2.1.9.1.1 below.

$$\mathbf{h} = \frac{\mathbf{k} \times \mathbf{n}}{|\mathbf{k} \times \mathbf{n}|} \qquad \text{EQUATION 3-1}$$

$$\mathbf{v} = \mathbf{h} \times \mathbf{k} \qquad \text{EQUATION 3-2}$$

where: **n** is the geodetic local vertical (unit normal) at the Earth's surface and **k** is the unit vector in the direction of the CMIS line-of-sight.

FIGURE 3.2.1.9.1.1 Illustration of the Vertical and Horizontal Polarization Alignment and Geometry for the CMIS.

(TBS)

The plane of incidence, for a given CMIS channel, is defined as the plane containing the geodetic local vertical (**n**) and the CMIS antenna beam LOS (**k**) for that channel.

3.2.1.9.1.2 Polarization Alignment

SRDC3.2.1.9.1.2-1
Each vertically-polarized beam shall have its polarization direction lie in the plane of incidence within ± (TBD) degrees (see Figure 3.2.1.9.1.1).

SRDC3.2.1.9.1.2-2
Each horizontally-polarized beam shall have its polarization direction normal to the plane of incidence to within ±(TBD) degrees (see Figure 3.2.1.9.1.1).

SRDC3.2.1.9.1.2-3
An analysis shall be provided which demonstrates that both of the above requirements are satisfied.

3.2.1.9.1.3 Orthogonality

SRDC3.2.1.9.1.3-1
The vertically- and horizontally-polarized antenna beams shall be aligned orthogonally to within □(TBD) degrees.

3.2.1.9.1.4 Cross Polarization Isolation

SRDC3.2.1.9.1.4-1
The integrated cross polarization rejection ratio of the orthogonal feedhorn antenna polarizations within each CMIS channel antenna beam shall be at least (TBD) dB.

3.2.1.9.2 Antenna Polarization Characteristics for Polarimetric Channels

SRDC3.2.1.9.2-1
If polarimetric channels are used then the following requirements shall apply in addition to the antenna polarization requirements in Section 3.2.1.9.1.

SRDC3.2.1.9.2-2
The antenna polarizations used by each CMIS polarimetric channel shall be consistent with performing measurements of T_U and/or T_V which will meet the sensitivity (Section

3.2.1.4), measurement accuracy (Section 3.2.1.5.3), and EDR requirements (Section 3.2.1.1.1.1).

SRDC3.2.1.9.2-3
Any antenna feedhorn(s) used for CMIS polarimetric channel(s) shall meet the minimum requirements for polarization alignment, orthogonality, and cross-polarization isolation as stated below in Sections 3.2.1.9.2.1, 3.2.1.9.2.2, and 3.2.1.9.2.3.

SRDC3.2.1.9.2-4
An error analysis/budget for the CMIS polarization of all channels, which includes all relevant error sources, shall be provided.

3.2.1.9.2.1 Polarization Alignment for Polarimetric Channels (TBR)

SRDC3.2.1.9.2.1-1
Each vertically polarized beam shall have its polarization direction lie in the plane of incidence to within ±(TBD) degrees (see Figure 3.2.1.9.1.1).

SRDC3.2.1.9.2.1-2
Each horizontally-polarized beam shall have its polarization direction normal to the plane of incidence to within ± (TBD) degrees (see Figure 3.2.1.9.1.1).

3.2.1.9.2.2 Orthogonality Requirement for Polarimetric Channels

SRDC3.2.1.9.2.2-1
The vertically- and horizontally-polarized antenna beams shall be aligned orthogonally within (TBD) degrees.

3.2.1.9.2.3 Cross Polarization Isolation Requirement for Polarimetric Channels

SRDC3.2.1.9.2.3-1
The integrated cross polarization rejection ratio between orthogonally-polarized channels within each antenna beam shall be at least (TBD) dB.

3.2.1.9.3 Polarization Purity (TBR)

SRDC3.2.1.9.3-1
Each CMIS channel shall contain 99 percent of the specified polarization.

SRDC3.2.1.9.3-2
Each CMIS polarimetric channel shall contain (TBD) percent of the specified polarization.

3.2.1.10 Calibration (TBR)

SRDC3.2.1.10-1
The CMIS sensor shall require factory pre-launch (ground) and on-orbit calibration.

SRDC3.2.1.10-2
Any external operational calibration techniques shall not affect the normal operating and sensing performance for scene brightness temperatures through the feed system nor cause sun glint into the CMIS, or any other NPOESS sensor.

SRDC3.2.1.10-3
There shall be no time dependent feed horn effects caused by the CMIS calibration implementation, such as Voltage to Standing Wave Ratio (VSWR) changes, of such a magnitude as to cause the CMIS calibration, measurement accuracy, sensitivity and EDR requirements specified in this document not to be met.

SRDC3.2.1.10-4
Any calibration system shall have view angles and other properties that are compatible with the NPOESS spacecraft and all other on-board sensors.

3.2.1.10.1 Type of Calibration

3.2.1.10.1.1 Pre-launch Calibration

The CMIS pre-launch calibration will consist of all tests necessary to measure and characterize the radiometric accuracy of the CMIS over the range of expected on-orbit environmental conditions and the CMIS operational states and modes. The CMIS pre-launch calibration will also provide a complete characterization and validation of the on-orbit calibration and instrument performance. The CMIS pre-launch calibration will utilize, as required, the necessary calibration reference standards as calibration sources.

The CMIS pre-launch calibration will also provide a characterization and validation of the contractor's calibration model. The calibration model, for each CMIS channel, will be used to relate the CMIS output to radiometric input over the dynamic range and operating conditions of the CMIS sensor.

3.2.1.10.1.2 On-orbit Calibration

The CMIS on-orbit calibration will consist of all hardware and measurements necessary to perform a calibration of each CMIS channel during on-orbit operations, at least once per scan.

SRDC3.2.1.10.1.2-1
The CMIS shall incorporate an on-orbit calibration system that uses a minimum of two signal levels (hot and cold effective scene brightness temperatures) to calibrate each CMIS channel. The calibration approach may use internal, external, or any combination of sources necessary to meet the measurement accuracy requirements given in Table 3.2.1.5.1.2, Table 3.2.1.5.2.2, and the CMIS EDR requirements.
An external cold calibration source, if used, may utilize a cold sky view.

SRDC3.2.1.10.1.2-2
The CMIS contractor shall provide the spacecraft contractor the necessary information and requirements to accommodate the clear field of view that such a target would require.

3.2.1.10.2 Frequency of Calibration

3.2.1.10.2.1 Pre-launch Calibration

SRDC3.2.1.10.2.1-1
The pre-launch calibration shall be performed prior to CMIS delivery.

SRDC3.2.1.10.2.1-2
If the period between delivery of the CMIS and integration onto the spacecraft exceeds (TBS) months, then the pre-launch calibration shall be repeated before integration onto the spacecraft.

SRDC3.2.1.10.2.1-3
If the CMIS has been in storage prior to spacecraft integration for longer than (TBS) months, then the pre-launch calibration shall be repeated before integration onto the spacecraft.

SRDC3.2.1.10.2.1-4
If the CMIS has been in storage after integration onto the spacecraft for longer than (TBS) months, then the contractor shall make recommendations for any pre-launch calibration requirements.

3.2.1.10.2.2 On-orbit Calibration

SRDC3.2.1.10.2.2-1
Calibration of each CMIS channel shall occur at least once per scan.

SRDC3.2.1.10.2.2-2
The number of calibration samples taken during each scan shall be sufficient to meet all measurement accuracy, sensitivity, and EDR performance requirements.

3.2.1.10.3 Calibration Source Requirements

3.2.1.10.3.1 Pre-launch Calibration

SRDC3.2.1.10.3.1-1
External thermal calibration sources suitable for the pre-launch calibration of all CMIS channels shall be provided. The external thermal calibration sources will be referred to as calibration targets.

3.2.1.10.3.1.1 Pre-launch Calibration Target Emissivity

SRDC3.2.1.10.3.1.1-1
The pre-launch calibration target(s) shall have a minimum measured emissivity of (TBD), for each CMIS channel.

SRDC3.2.1.10.3.1.1-2
The emissivity shall be measured in accordance with the specifications given in Document (TBS).

3.2.1.10.3.1.2 Pre-launch Calibration Target Range of Temperatures

SRDC3.2.1.10.3.1.2-1
The pre-launch calibration targets shall be capable of providing standard reference brightness temperatures over the temperature range (TBD) K to (TBD) K.

3.2.1.10.3.1.3 Pre-launch Calibration Target Temperature

SRDC3.2.1.10.3.1.3-1
Temperature differences between any temperature controlled surface and the surface viewed by the CMIS radiometer channels shall be less than (TBS) K.

SRDC3.2.1.10.3.1.3-2
The temperature of the pre-launch calibration target shall be continuously monitored during all calibration tests using NIST traceable temperature transducers.

SRDC3.2.1.10.3.1.3-3
The temperature measurements shall be accurate to ± (TBD) K.

3.2.1.10.3.1.4 Pre-launch Calibration Target Brightness Temperature Uniformity

SRDC3.2.1.10.3.1.4-1
The maximum brightness temperature variation over the effective aperture of the pre-launch calibration target(s) shall be less than (TBD) K at any of the brightness temperatures specified in paragraph 3.2.1.10.3.1.2. The effective aperture of the pre-launch calibration target is defined as the 90 percent energy contour of the corresponding feedhorn antenna under test.

SRDC3.2.1.10.3.1.4-2
The brightness temperature of the pre-launch calibration target(s) shall be constant to within (TBS) K during the pre-launch calibration, at any of the brightness temperatures specified in paragraph 3.2.1.10.3.1.2.

3.2.1.10.3.1.5 Pre-launch Polarimetric Calibration Source Requirements

SRDC3.2.1.10.3.1.5-1
If the CMIS sensor includes polarimetric channels, a polarimetric calibration source shall be provided for the pre-launch calibration of the corresponding polarimetric channels.

SRDC3.2.1.10.3.1.5-2
(TBR) The polarimetric calibration source shall provide the appropriate Stokes parameters (T_U or T_V) to the CMIS feedhorn antenna with at least a dynamic range of ± 10 K for T_U and ± 2 K for T_V relative to the mean background brightness temperature.

SRDC3.2.1.10.3.1.5-3
The T_U or T_V signals shall be provided with an absolute accuracy of ± (TBD) K.

SRDC3.2.1.10.3.1.5-4
The polarimetric calibration source shall also provide vertically- and horizontally-polarized scene brightness temperatures over the range specified in Section 3.2.1.10.3.1.2.

3.2.1.10.3.1.6 Pre-launch Calibration of Internal Calibration Source(s)

SRDC3.2.1.10.3.1.6-1
If the CMIS sensor utilizes internal calibration source(s), the internal source calibration shall be verified by an end-to-end calibration with an external calibration target over the range of brightness temperatures specified in Section 3.2.1.10.3.1.2.

3.2.1.10.3.2 On-orbit Calibration

SRDC3.2.1.10.3.2-1
The calibration sources employed for on-orbit calibration of the CMIS shall provide sufficiently accurate radiometric brightness temperature or noise power so as to enable the CMIS to meet all radiometric measurement accuracy requirements listed in Tables 3.2.1.5.1.2 and 3.2.1.5.2.2, and the EDR requirements in Section 3.2.1.1.1.1.

3.2.1.10.3.2.1 On-orbit Calibration Target Emissivity

SRDC3.2.1.10.3.2.1-1
Any external on-orbit calibration targets shall have a measured emissivity of (TBD).

SRDC3.2.1.10.3.2.1-2
The external on-orbit calibration target emissivity shall be measured in accordance with the specifications given in Document (TBS).

3.2.1.10.3.2.2 On-orbit Calibration Target Range of Effective Brightness Temperatures

SRDC3.2.1.10.3.2.2-1
The external on-orbit calibration target shall be capable of providing effective brightness temperatures over the temperature range (TBD) K to (TBD) K.

3.2.1.10.3.2.3 On-orbit Calibration Target Temperature

SRDC3.2.1.10.3.2.3-1
Temperature differences between any temperature controlled surface and the surface viewed by the CMIS radiometer channels shall be less than (TBS) K.

SRDC3.2.1.10.3.2.3-2
The temperature of any on-orbit external calibration target shall be continuously monitored using National Institute of Standards and Technology (NIST) traceable temperature transducers.

SRDC3.2.1.10.3.2.3-3
The temperature measurements shall be accurate to ± (TBD) K.

3.2.1.10.3.2.4 On-orbit Calibration Target Brightness Temperature Uniformity

SRDC3.2.1.10.3.2.4-1
The maximum brightness temperature variation over the effective aperture of any on-orbit calibration target(s) shall be less than (TBD) K. The effective aperture of the on-orbit calibration target is defined as the 90 percent energy contour of the corresponding feedhorn antenna under test.

SRDC3.2.1.10.3.2.4-2
The brightness temperature of any on-orbit calibration target(s) shall be constant to within (TBS) K during the on-orbit calibration period.

3.2.1.10.3.2.5 On-orbit Internal Calibration Source Requirements

SRDC3.2.1.10.3.2.5-1
If internal calibration sources are to be used on-orbit, the calibration of the CMIS channels utilizing the internal calibration sources shall meet the measurement accuracy (Section 3.2.1.5) and EDR performance requirements.

3.2.1.10.4 Calibration Error Analysis

3.2.1.10.4.1 Pre-launch Calibration

SRDC3.2.1.10.4.1-1
An error analysis/budget for the CMIS pre-launch calibration, which includes all relevant error sources to the pre-launch calibration, shall be provided to the government.

SRDC3.2.1.10.4.1-2
The following error sources shall be included as a minimum:

- Calibration target temperature uniformity and measurement error
- Non-blackbody emissivity of calibration target
- Imperfect coupling between the feedhorn and calibration targets (e.g., unwanted energy entering the feedhorn)
- Cross-polarization coupling errors
- Antenna feedhorn spillover
- Feedhorn to reflector alignment errors
- Antenna reflector emissions
- Quantization error
- The effect of incident radiation outside of the feedhorn antenna’s 90 percent energy contour (sidelobe effects)
- Non-linear radiometer transfer function

Calibration algorithms (such as antenna pattern correction) may be required to meet calibration accuracy requirements (TBR).

3.2.1.10.4.2 On-orbit Calibration

SRDC3.2.1.10.4.2-1
An error analysis/budget for the CMIS on-orbit calibration which includes all relevant error sources to the on-orbit calibration shall be provided to the government.

SRDC3.2.1.10.4.2-2
The error sources shall include as a minimum those identified in Section 3.2.1.10.4.1.

3.2.1.11 Doppler Correction or Tracking (TBR)

The CMIS contractor should consider the effects of the relative motion of the satellite and CMIS sensor scan LOS on the retrieval of atmospheric EDRs.

SRDC3.2.1.11-1
The CMIS contractor shall account for these effects in either the CMIS hardware design or science algorithms or both.

3.2.1.12 Earth Location Requirements

3.2.1.12.1 Definition

The alignment of the CMIS relative to the spacecraft, and knowledge of the CMIS LOS in conjunction with the spacecraft attitude and ephemeris data, will allow the Earth location of the CMIS sensor data.

SRDC3.2.1.12.1-1
The Earth location shall be in geodetic latitude and longitude, corrected for altitude within the accuracy specified for each EDR in Section 3.2.1.1.1.1.

3.2.1.12.2 Requirements

3.2.1.12.2.1 Allocations

SRDC3.2.1.12.2.1-1
The CMIS contractor shall be responsible for meeting the EDR Earth location requirements, based on the allocations from the spacecraft level as specified in Section 3.2.4.2.1.3.

SRDC3.2.1.12.2.1-2
The CMIS contractor shall provide a complete analysis of the Earth location error budget.

SRDC3.2.1.12.2.1-3
This shall include, but is not limited to, the allocations from the spacecraft, the CMIS sensor design allocations, alignment requirements between the CMIS and the spacecraft, and development and validation of the Earth location algorithm for the CMIS data.

SRDC3.2.1.12.2.1-4
The CMIS contractor shall communicate all data requirements necessary to perform this function to the IPO and prime contractor.

TABLE 3.2.1.12.2 EARTH LOCATION REQUIREMENTS ERROR BUDGET

(TBD)

3.2.1.12.3 Sensor Reference Axes Alignment

SRDC3.2.1.12.3-1
The CMIS shall have a well defined set of three orthogonal reference axes.

SRDC3.2.1.12.3-2
This set shall include a vertical reference axis.

SRDC3.2.1.12.3-3
These axes shall be used as reference axes for alignment of the CMIS LOS and the overall alignment of the CMIS to the NPOESS spacecraft. (see paragraph 3.2.1.8.2.1).

SRDC3.2.1.12.3-4
Any additional reference positions and alignment axes shall be determined by the CMIS contractor and provided to the IPO and prime contractor.

(**TBS**)

3.2.1.12.4 CMIS Line-of-Sight (LOS) Pointing Knowledge

(**TBD**)

3.2.1.12.5 CMIS LOS Jitter and Drift Requirements

3.2.1.12.5.1 Definition of Jitter

(**TBS**)

3.2.1.12.5.2 Requirements

(**TBD**)

3.2.1.12.5.3 Definition of Drift

(**TBS**)

3.2.1.12.5.4 Requirements

(**TBD**)

3.2.1.13 Standard Earth Scenes

The NPOESS IPO will provide up to 5 (TBR) microwave images representing different sea states and soil moisture content in each of the 20 (TBR) daytime non-desert categories/areas (diurnal variations and deserts will be neglected) listed below, for use in developing imager designs, and in verifying imager and algorithm performance. The government will create an additional set of up to 5 images in each area/category which will be used by the government to determine sensor design performance and algorithm performance.

Climate Area	Spring	Summer	Autumn	Winter	Location (NW Corner)
Polar					
Land: Siberia		X		X	70N 103E
Coast: Point Barrow		X		X	72N 159W
Tropics					
Land: Amazon Basin		X		X	5S 65W
Coast: Cameroon		X		X	5N 8E
Ocean: E. Pacific		X			8N 120W
Midlatitudes					
Land: W. Urals	X	X	X	X	56N 56E
Coast: Olympic Peninsula	X	X	X	X	48N 126W
Ocean: Azores				X	45N 30W
Alpine: Swiss Alps			X		48N 8E
Sub-Tropical: Bangladesh				X	25N 88E

Images will have a Horizontal Spatial Resolution (HSR) of 7.5 km (TBR) and will include 64 X 64 (TBR) pixels. The images will represent top of the atmosphere radiance in-channel for each Stokes parameter, with channels selected by the contractor to match their sensor channels. The number of image channels, including both the frequency and polarization, will not exceed 24. Contractors with more than 24 channels in their design must select which 24 channels they desire as standard scenes. After delivery of the initial set of images, contractors may request copies of the executable models and the input datasets and commands used to create the images if they wish to generate additional scenes in other channels. Sensor responsivity will be assumed to be a top-hat (TBR), because alternate sensor response functions can be characterized and calibrated out. Sea surface data underlying the images will be constructed from a (TBS) sea surface model. Land surface data underlying the images will be constructed from a (TBS) microwave surface model. Clouds will be inserted into the images as graybody radiators with scattering as appropriate and with specified optical depth, particle size, and cloud base and top heights. Top of the atmosphere radiance values will be computed using (TBS) microwave radiance model. Image files will be supplied as binary data in raster format, with a 32 bit floating point value for each pixel, and with 1 channel and Stokes parameter per file (TBR). Files will be supplied on TAR tapes (TBR).

The NPOESS IPO will provide up to 5 sounder datasets in each of the categories/areas listed below for use in developing sounder designs, and in verifying sounder and algorithm performance. There are 24 areas in all. For each area except polar, there will be day and night categories as well, making the total 44 areas/categories (TBR) of standard datasets. The government will create an additional set of up to 5 images in each area/category which will be used by the government to determine sensor design performance and algorithm performance.

Climate Area	Spring	Summer	Autumn	Winter	Location (NW Corner)
Polar					
Land: Siberia		X		X	70N 103E
Coast: Point Barrow		X		X	72N 159W
Tropics					
Land: Amazon Basin		X		X	5S 65W
Coast: Cameroon		X		X	5N 8E
Ocean: E. Pacific		X			8N 120W
Midlatitudes					
Land: W. Urals	X	X	X	X	56N 56E
Coast: Olympic Peninsula	X	X	X	X	48N 126W
Desert: Great Basin	X	X	X	X	41N 118W
Ocean: Azores				X	45N 30W
Alpine: Swiss Alps			X		48N 8E
Sub-Tropical: Bangladesh				X	25N 88E

Sounder datasets will cover subsets from the areas identified for images. Each sounder area will consist of an area equal to 5 X 5 HSRs (TBR) for the channel with the largest HSR for the sensor design, but will have a HSR of 7.5 km (TBR). Datasets will provide radiance values for each channel requested by the contractor. No limit on the number of channels is specified, however, more than (TBS) channels must be justified by the contractor. The number of sounding channels modeled, including both the frequency and polarization, will not exceed 50. Contractors with more than 50 channels in their design must select which 50 channels they desire as standard sounder datasets. After delivery of the initial set of sounding datasets, contractors may request copies of the executable models and the input datasets and commands used to create the soundings if they wish to generate additional data in other channels. Sensor responsivity will be assumed to be a top-hat (TBR), because alternate sensor response functions can be characterized and calibrated out.

Radiance data will be based on ground truth profiles of temperature, water vapor, and ozone, and will be computed with (TBS) microwave radiance model for microwave channels. The temperature, water vapor, and ozone profiles will be available for each dataset given to the contractor. Cloud/no-cloud masks, at the smallest HSR, will be

provided with each sounder dataset. Sounder dataset files will be supplied as binary data in raster format, with a 32 bit floating point value for each pixel, and with 1 channel per file (TBR). Files will be supplied on TAR tapes (TBR).

3.2.1.14 Data Formatting and Compression (TBR)

SRDC3.2.1.14-1
The data packets generated by the CMIS shall conform to the Consultative Committee for Space Data Systems (CCSDS) packetization per the (TBS) real time interface specification and the (TBS) stored data interface specification.

SRDC3.2.1.14-2
If data compression techniques are utilized by the CMIS in generating data packets for storage on-orbit, the compression shall be lossless.

SRDC3.2.1.14-3
The CMIS may utilize lossy data compression in generating data packets for real time transmission of mission data to field terminals via either high or low data rate links, with the exception of sensor calibration data.

SRDC3.2.1.14-4
If the CMIS utilizes data compression techniques in generating data packets for real time transmission of sensor calibration data to field terminals, via either high or low data rate links, the compression shall be lossless.

SRDC3.2.1.14-5
The CMIS contractor shall identify and quantify any EDR performance degradation at the field terminals resulting from the use of lossy data compression.

3.2.2 SENSOR CAPABILITY RELATIONSHIPS

3.2.2.1 Reference Timelines

TBD

3.2.3 INTERFACE REQUIREMENTS

The system interfaces relevant to the sensors are depicted in Figure 3.2.3 below:

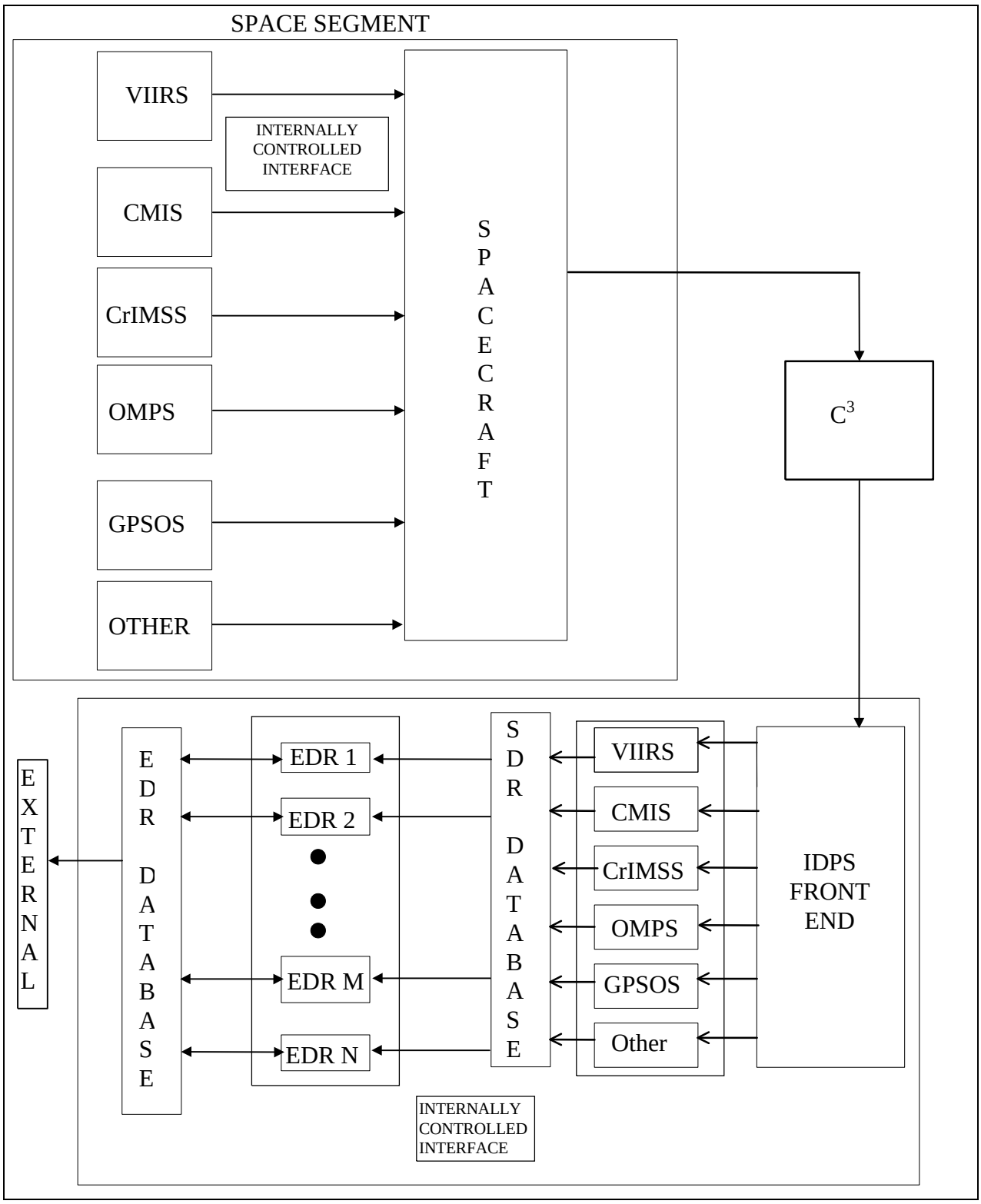

Figure 3.2.3 Partial System Internal Interfaces

3.2.4 PHYSICAL AND INTERFACE CHARACTERISTICS

The weight, power, volume and data rates described herein represent the Goal, Target, and Not-to-Exceed values for the CMIS instrument. The Goal values represent the lowest realistic values developed during initial studies at the Integrated Program Office (IPO). The Target values represent the most probable estimate of the particular CMIS parameter, while the Not-to-Exceed values represent the maximum acceptable values for the CMIS instrument. Relaxation of the Not to Exceed requirement will only be possible if changes are consistent with the requirement to accommodate the full NPOESS payload suite of instruments on a spacecraft which can be placed in a nominal 833 km orbit by an EELV-class launch vehicle.

The CMIS notional baseline provides for the CMIS to be mounted on the zenith surface of the NPOESS spacecraft in order to prevent intrusions into the fields of view of other sensors. Alternative mounting locations will be considered by the NPOESS Program, but will not be approved until satisfactory accommodation of other sensors on the spacecraft has been demonstrated.

3.2.4.0.1 Deleted

SRDC3.2.4.0.1-1 DELETED.

SRDC3.2.4-1

The Goal, Target, and Not-to-Exceed values for the complete CMIS sensor mass (including all subsystems, deployment mechanisms, mounting hardware, cabling, etc.) are given in Table 3.2.4a. The mass of the complete CMIS sensor (including all subsystems, deployment mechanisms, mounting hardware, cabling, etc.) shall be less than the Not-to-Exceed value specified in Table 3.2.4a.

CMIS Mass	kg
Goal	178
Target	201
Not-to-Exceed	TBD

Table 3.2.4a CMIS sensor Mass

3.2.4.0.2 Deleted

SRDC3.2.4.0.2-1 DELETED

SRDC3.2.4-2

The notional CMIS consists of an antenna, rotating electronics canister, required momentum compensation, and additional electronics packages (if necessary). The values listed for the rotating electronics canister are considered to be the stowed dimensions of the canister, including any necessary deployment mechanisms. The

Goal, Target, and Not-to-Exceed values for the dimensions of the CMIS sensor components are given in Table 3.2.4b. The dimensions of the CMIS sensor subsystems shall be less than the Not-to-Exceed values specified in Table 3.2.4b.

CMIS Dimensions	Antenna Subassembly Dimension* (cm)	Electronics Canister (cm)	Additional Electronics Packages (cm)	Momentum Compensation Unit (cm)
Goal	220	46 x 46 x 55 (x,y,z)	TBD	TBD
Target	250	TBD	TBD	TBD
Not-to-Exceed	TBD	TBD	TBD	TBD

* Largest Stowed Dimension including mounting fixtures and other necessary hardware

Table 3.2.4b CMIS Sensor Dimensions

SRDC3.2.4-3
The swept volume of the deployed and nominally operating CMIS electronics canister and antenna subsystem shall be less than (TBD).

3.2.4.0.3 Deleted

SRDC3.2.4.0.3-1 DELETED.

SRDC3.2.4-4
The Goal, Target, and Not-to-Exceed values for the CMIS orbit average power consumption are given in Table 3.2.4c. The orbital average power consumption of the complete CMIS sensor (including all subsystems, electronics packages and momentum compensation) shall be less than the Not-to-Exceed value specified in

Table 3.2.4c.

CMIS Power	Watts
Goal	208
Target	227
Not-to-Exceed	TBD

Table 3.2.4c CMIS sensor Power

SRDC3.2.4-5
The peak power consumption and duration of the nominally operating CMIS sensor shall be specified in the contractor System-Spec.

3.2.4.0.4 Deleted

SRDC3.2.4.0.4-1 DELETED.

SRDC3.2.4-6
The Goal, Target, and Not-to-Exceed values for the CMIS sensor data rate are given in Table 3.2.4d. The data rate values are intended to be uncompressed, orbital averages. The uncompressed, orbital average CMIS sensor data rate shall be less than the Not-to-Exceed value specified in Table 3.2.4.d.

CMIS Data Rate	kbps
Goal	160
Target	TBD
Not-to-Exceed	TBD

Table 3.2.4d CMIS sensor Data Rate

SRDC3.2.4-7
The peak data rate, during nominal operation of the CMIS sensor, shall be specified in the contractor System/Subsystem-Spec.

3.2.4.0.5 Deleted.

Continued in Common Section
(Common Section applicable to CMIS & OMPS)